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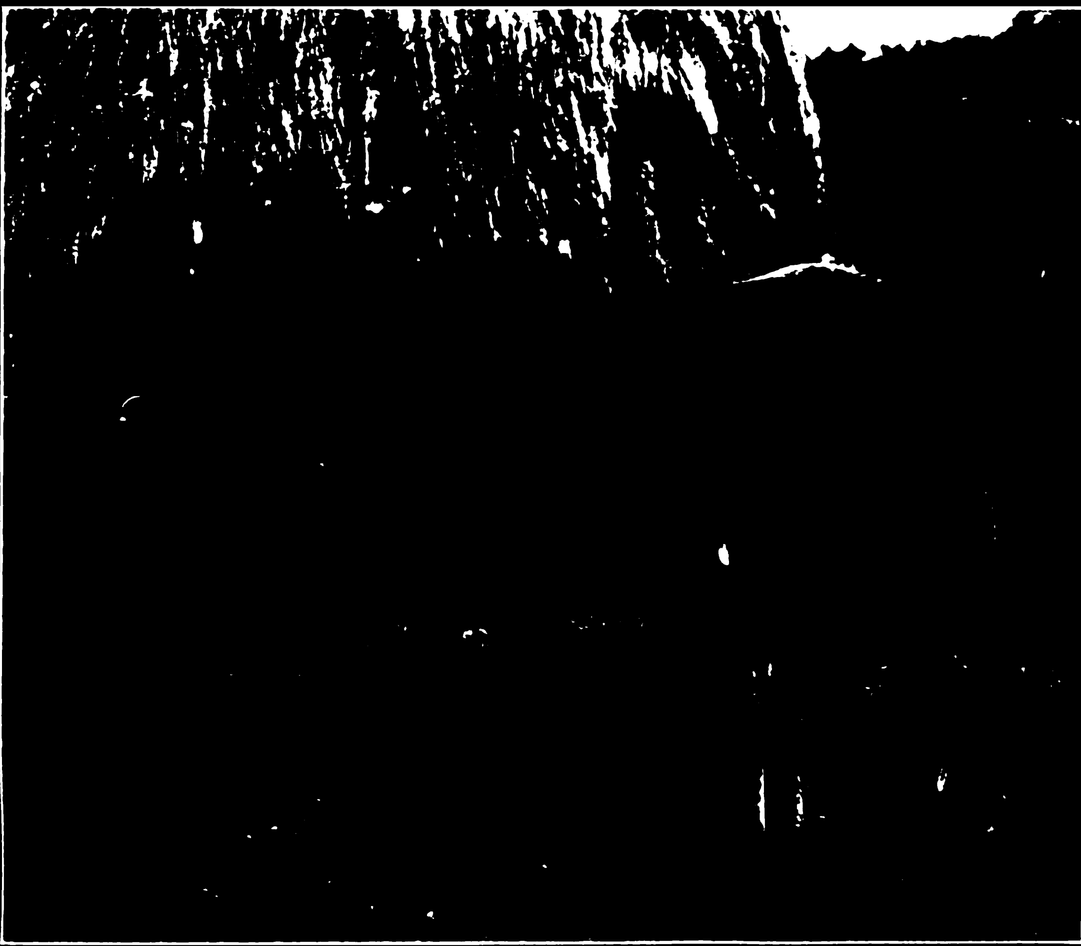

Annual Report of the Bureau of Animal Industry for the Year ...

United States Bureau of Animal Industry

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Issued February 10, 1912.

U. S. DEPARTMENT OF AGRICULTURE.

TWENTY-SEVENTH ANNUAL REPORT

OF THE

BUREAU OF ANIMAL INDUSTRY

FOR THE YEAR

1910.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1912.

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[STATUTES AT LARGE, VOL. 28 (CHAP. 23), P. 601.]

AN ACT Providing for the public printing and binding and the distribution of public documents.

SEC. 73. Extra copies of documents and reports shall be printed promptly when the same shall be ready for publication, and shall be bound in paper or cloth as directed by the Joint Committee on Printing, and shall be the number following in addition to the usual number:

Of the report of the Bureau of Animal Industry, 30,000 copies, of which 7,000 shall be for the Senate, 14,000 for the House, and 9,000 for distribution by the Agricultural Department.

Approved, January 12, 1895.

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., June 20, 1911.

SIR: I have the honor to transmit herewith the Twenty-seventh Annual Report of the Bureau of Animal Industry, for the year 1910, and recommend that it be published, as provided by section 73 of the act of Congress approved January 12, 1895.

Respectfully,

A. D. MELVIN,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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ORGANIZATION OF THE BUREAU OF ANIMAL INDUSTRY.

Chief: A. D. MELVIN.
Assistant Chief: A. M. FARRINGTON.
Chief Clerk: CHARLES C. CARROLL.
Animal Husbandry Division: GEORGE M. ROMMEL, chief.
Biochemic Division: M. DORSET, chief.
Dairy Division: B. H. RAWL, chief.
Inspection Division: RICE P. STEDDOM, chief; MORRIS WOODEN, R. A. RAMSAY, and ALBERT E. BEHNKE, associate chiefs.
Pathological Division: JOHN R. MOHLER, chief.
Quarantine Division: RICHARD W. HICKMAN, chief.
Zoological Division: B. H. RANSOM, chief.
Experiment Station: E. C. SCHROEDER, superintendent.
Editor: JAMES M. PICKENS.

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TWENTY-SEVENTH ANNUAL REPORT OF THE BUREAU OF ANIMAL INDUSTRY.

REPORT OF THE CHIEF OF THE BUREAU FOR THE FISCAL YEAR ENDED JUNE 30, 1910.

By A. D. Melvin.

INTRODUCTION.

The work of the Bureau of Animal Industry during the fiscal year ended June 30, 1910, consisted, as heretofore, of the meat inspection, the inspection of animals for export, the inspection and quarantine of imported animals, the eradication of contagious and infectious diseases of live stock, the scientific investigation of such diseases, investigations in the breeding and feeding of live stock and poultry, and work relating to the dairy industry.

The employees in the service of the bureau on July 1, 1910, numbered 3,183, as compared with 3,268 a year before. Of the former number 2,385 were engaged in meat inspection or work pertaining thereto, as compared with 2,499 on July 1, 1909.

MEAT INSPECTION.

As pointed out in my previous report, the meat inspection in the latter part of the fiscal year 1909 had about reached the limit of the standing annual appropriation of $3,000,000. Strict economy has been observed in this work so as to provide inspection to the greatest extent possible with the funds available. The cost of the inspection for the fiscal year 1910 was approximately $2,940,000.

While the inspection was carried on at 919 establishments in 237 cities and towns—an increase of 43 establishments over the preceding year—the total number of animals inspected was less, owing to a falling off in the number of hogs slaughtered. There was an increase in all other species. The total number of animals inspected at the time of slaughter was 49,179,057, as compared with 55,672,075 in the fiscal year 1909. Of the former number there were condemned because of disease or other condition 113,742 entire carcasses and 874,211 parts of carcasses, making a total of nearly 1,000,000 animals condemned in whole or in part. In addition there were condemned on

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reinspection over 19,000,000 pounds of meat and meat products which had become unwholesome since inspection at the time of slaughter. More detailed figures relating to the meat inspection appear in the portion of this report dealing with the work of the Inspection Division.

Notwithstanding the great improvement in sanitary conditions brought about under the additional authority given the department by the law of 1906, and the high degree of efficiency to which the service has been brought, the meat inspection is still occasionally the object of unjust criticism and misrepresentation. Some of these matters have been discussed in previous reports. Objection is sometimes made to the passing for food purposes of the meat of animals that are affected with localized tuberculosis or other localized disease or condition. It is sometimes falsely asserted that "diseased meat is passed for food." The only foundation for such statements is that the wholesome and healthy meat of an animal affected slightly and locally with some disease is passed, after the affected portion has been removed and condemned. The meat or flesh may not be affected in any particular, the disease being usually confined to certain glands or organs. The diseased portion is condemned; only the healthy portion is passed for food.

This procedure is justified and sustained by the highest scientific authorities not only in the United States but in all countries having an efficient meat inspection. Objections to it usually come from those who have not made a study of comparative pathology and who are not qualified to pass upon the questions involved, and sometimes they come from those who oppose the use of meat at all as food and who wish to discredit it in every possible way.

The idea of eating the meat of a slightly diseased animal may be repulsive to some, but a little consideration should readily convince a reasonable person that there is no valid reason for condemning and wasting perfectly wholesome meat simply because there happens to be somewhere in the animal a gland or an organ showing a lesion, or a parasitic nodule, or some slight, local condition which does not extend to or affect in any way the remainder of the carcass. The argument that all the meat of an animal affected to even the slightest degree with any disease should be totally and utterly condemned, if carried to the extreme and to its logical end, would result in the condemnation of practically every animal slaughtered and the abolition of meat as food.

With the increasing cost of the necessaries of life it becomes more important that wholesome food should not be recklessly and needlessly destroyed, and it is the duty of this department not only to protect the people against unwholesome meat, but to conserve the food supply. The only sensible course in meat inspection is to determine

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at just what stage a disease or abnormal condition becomes noxious, and where to draw the line between what should be condemned and what should be passed, always giving to the consumer the benefit of any doubt. That the department does properly safeguard the consumer is well shown in the report of a commission of eminent scientists outside the department, who were appointed in 1907 by the Secretary of Agriculture at the suggestion of President Roosevelt to consider and make recommendations with regard to certain features of the meat inspection, and who stated as their conclusion that "if there be any general error in the regulation, this is in favor of the public rather than in favor of the butchers and packers."

With regard to the question now under discussion the commission said:

The commission would invite attention to a very widespread popular misconception as to the significance of the word "diseased" in connection with meat inspection. To the popular mind the idea of eating "diseased" animals is abhorrent. From the standpoint of meat inspection, however, the term "diseased" must be used in a sense not entirely in harmony with the popular conception of this word.

The commission could easily undertake to show that not any single animal used for food in any part of the world would, upon microscopic study, be shown to be absolutely free from all infection or lesion if said animal were presented to it for examination. Some persons might assert that in all of these infections and conditions the meat of the animals should be considered "diseased." Such interpretation is not, however, justified from a standpoint of meat inspection. A light sarcosporidiasis[1] in cattle, sheep, swine, or goats, for instance, would not justify the condemnation of a carcass, for there is no proof that such a condition depreciates, in even the remotest degree, the value of the meat or that this infection is transmissible to man. Likewise, there may be a strictly localized tuberculosis, consisting, for instance, of an isolated tuberculous nodule in the lungs, in the liver, or in some other portion of the body. Such nodule would make the particular point infected "diseased" from the standpoint of meat inspection; in the opinion of some members of the laity, such nodule would also make the entire meat of the animal "diseased" and call for the condemnation of the entire carcass; from the standpoint of meat inspection, the carcass in general would not be "diseased," and there would be no justification in condemning it.

The veterinary inspector, in judging whether a carcass is "diseased," must do so upon the general principles of pathology in its relation to the public health, and not upon any preconceived, exaggerated, or sentimental idea.

The commission would suggest that the cooperation of the public is most valuable in aiding in the suppression of frauds in the meat trade, but that it would be well for the public to have confidence in the ability of the veterinary inspectors to pass judgment upon the purely technical side of the questions involved, since such judgment can be of value only when expressed by persons especially trained for this purpose.

Illustrative of the precautions taken by the Department of Agriculture to safeguard the public health, it is the opinion of the commission that the Bureau

[1] One of the most common infections of food animals, especially of hogs. It is due to the presence of a minute parasitic protozoon in the muscles.

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of Animal Industry, acting under the existing regulations, would necessarily condemn certain meats which would be allowed, either with or without restrictions, according to circumstances, upon the markets of Germany, France, England, and other countries.

It is only when the disease is slight and localized or circumscribed that the unaffected portions of the carcass are passed for food. Whenever the disease is generalized or disseminated throughout the system, or is of such character or extent as to affect the wholesomeness of the meat, the entire carcass is condemned—and the consumer is given the benefit of every doubt. Careful experiments carried out by the bureau and by scientists elsewhere have shown that the germs of tuberculosis are not carried in the blood circulation and distributed throughout the system until the disease has reached a very advanced stage. It is therefore considered perfectly safe, when the infection is clearly limited to a certain gland or group of glands or an organ, to remove these parts and pass the healthy parts which have not become affected in any way by the disease. The men who pass on these questions are well educated in veterinary science and comparative pathology, and are carefully trained in meat inspection, and hence have special knowledge of animal diseases and their bearing on human health.

It is safe to say that most of the meat which is condemned under the Federal inspection would be sold for food if it were not for this inspection. A considerable quantity of diseased and unwholesome uninspected meat is really placed upon the market, as the Federal inspection covers but little more than one-half of the total meat supply of the United States. A large part of the remainder receives no inspection whatever, while a small proportion is subjected to some kind of inspection by State or local officers. As pointed out in previous reports, it is important that the States and municipalities should provide an efficient inspection for the meat that is slaughtered and sold locally, and hence is beyond the control of the Federal Government. In some of the States and in quite a number of cities this subject is receiving consideration with a view to inaugurating inspection. An inspection to afford real protection to the health of the public should be made preferably by a competent veterinarian at the time of slaughter, and the places at which meat is slaughtered and prepared for food should be maintained in good sanitary condition.

It often happens that the local authorities must deal with small, scattered, poorly equipped, and very insanitary abattoirs, so that it is difficult and expensive to maintain proper supervision and to enforce proper sanitation. To meet such conditions there should be a central public abattoir where all the slaughtering of the community should be concentrated, and no slaughtering should be permitted elsewhere except at properly equipped places under proper inspection.

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Such a central abattoir may be under either municipal or private ownership. but in either case it should be under official supervision. The city of Paris, Tex., has erected a municipal abattoir which is in successful operation, and other cities are considering similar action. The Bureau of Animal Industry is endeavoring to assist in such local enterprises by furnishing such information and advice as it can give with regard to the designing, construction, equipment, and operation of public abattoirs, and it is expected that later the bureau will be prepared to furnish municipal authorities with plans and specifications when desired.

PROPOSED DEPARTMENT OR BUREAU OF PUBLIC HEALTH.

However commendable may be the movement to provide better Government facilities for safeguarding and promoting human health, the specific measures which are being urged upon Congress, if carried into effect, would unquestionably be very detrimental to the work which is now being carried on by the Bureau of Animal Industry, and also to the agricultural interests and in some respects to the public welfare.

Several bills are pending in Congress for the establishment of a department or bureau of public health. By one bill it is proposed to establish a new executive department and to transfer to that department not only the Bureau of Animal Industry and certain other branches of the Department of Agriculture, but all matters within the control of the Federal Government relating to "diseases of animal life" and all departments and bureaus (excepting those in the War and Navy Departments) "affecting the * * * biological * * * service, or any questions relative thereto." This language is so broad as to cover work relating to plant life, such as forestry, the growing of field crops, fruit culture, etc. To place work of this kind in a department of public health is so preposterous that it is doubtful if the advocates of the measure really intend to do this; yet such is the meaning of the langauge employed in the bill.

Much of the work of the Bureau of Animal Industry relates to such subjects as the breeding and feeding of live stock and poultry, and dairy practice and methods, including the manufacture of cheese, butter, etc. Obviously, such lines of work have no place in a department or bureau of public health, and their control can not be fairly regarded as in any way essential to the establishment and proper conduct of an efficient public-health organization.

Other bills pending before Congress, not so sweeping in scope, provide for the transfer to the proposed department or bureau of public health of the veterinary work of the Bureau of Animal Industry, including the meat inspection; but such a division and transfer would, in my judgment, seriously impair the efficiency of the

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service. Experience in this and other countries has shown that work such as the scientific investigation and the eradication of diseases of animals and the meat inspection should not only be performed by veterinarians but should be under veterinary control and direction. It is no reflection upon the medical profession to say that a physician, no matter how capable, is not qualified, without proper veterinary training, to conduct or direct such work.

The Bureau of Animal Industry is essentially an agricultural organization and deals primarily with agriculture, and its logical place is in the Department of Agriculture, even though some branches of its work have an important bearing on the public health. Even in the portions of the bureau's work of which the protection of human health is an important object, the problems are mainly agricultural and must be attacked from the agricultural side.

The production and conservation of the public food supply are of the highest importance to human health, but the measures by which such production and conservation are accomplished are mainly agricultural. In other words, while the end is a matter of public health, the means of accomplishing that end constitute an agricultural problem; and the Department of Agriculture is certainly the most appropriate agency for carrying out such agricultural means. To maintain an adequate supply of food-producing animals to meet the needs of the people, not only must methods of breeding and feeding live stock be studied and applied, but diseases of animals must be studied and combated; and all this work is an integral part of one great problem and should not be divided.

The large amounts expended by the Government for the protection of the health of live stock are sometimes contrasted with the small appropriations for protecting and promoting the health of the people. Such comparisons are fallacious and misleading. The money appropriated by Congress for the work of the Bureau of Animal Industry is not appropriated because of any sentimental feeling for the welfare of the animals themselves, but the real object is to provide a sufficient and wholesome supply of food for the preservation of human life and health.

In the interest of economy and good administration it is important that the work of the Bureau of Animal Industry should remain intact and in the Department of Agriculture. It is folly to argue that the consolidation of the various Government agencies having a bearing in any way on the public health into one organization would be a measure of financial economy. If this bureau were removed from the Department of Agriculture, it would be essential for that department to replace a large part of the organization if it continued to deal efficiently with agriculture, and this would duplicate and increase expenses instead of reducing them. The present organiza-

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tion permits the use of the same men (under various appropriations) in different lines of work and their transfer from time to time to meet the needs of the service—an arrangement that would not be possible if the work were divided by the transfer of the meat inspection to the proposed new organization. As pointed out in my report for the preceding year, the field work in eradicating diseases of animals is mostly done during the summer, while the work of slaughterhouses is heaviest during the winter; and a number of men can be utilized for field work in the summer and for meat inspection in the winter, thus effecting an economy which would not be possible if these lines of work were not under the same management. A striking illustration of the advantage of the present organization was given in that report with reference to the outbreak of contagious foot-and-mouth disease in the winter of 1908, when it was possible to draw immediately on a trained force of veterinarians and scientists already engaged in the meat inspection and other regular work of the bureau. Had these branches been separated, the contagion would very probably have spread widely and reached the great stock-raising regions of the West before a force could have been organized to combat it, and there it would have caused tremendous damage and loss and its eradication would have been exceedingly difficult and expensive, if not impossible.

It seems that it should be entirely possible and practicable for the Government to enlarge its work for human health and to maintain an efficient public-health organization without placing under that organization work which has no logical place there and without impairing existing branches of the Government service with no corresponding benefit to the public.

STUDY AND ERADICATION OF CONTAGIOUS DISEASES OF ANIMALS.

The scientific investigation of various animal diseases has been continued, and the policy of having such diseases studied in the field by a larger number of experts than heretofore has been adopted. The work for the eradication of certain contagious diseases has been unusually effective during the past year.

ERADICATION OF CATTLE TICKS.

With the steady extension of the zone affected by the ravages of the cotton-boll weevil and the growing realization by southern farmers of the need of giving more attention to stock raising, the value of the work being done for the extermination of cattle ticks becomes more apparent, and the people of the tick-infested territory are showing greater interest in this undertaking. Much has been done in the way of developing the hog, sheep, and poultry industries

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in the South and the introduction and breeding of a better class of animals, and hog raising especially has been demonstrated to be successful and profitable there; but the important industries of cattle raising and dairying can never be brought to a high degree of success as long as the South remains under the heavy handicap of the cattle tick. These ticks not only keep the cattle in poor condition, but spread the infection of the disease known as Texas fever, which makes it necessary to quarantine the cattle of tick-infested regions and to allow them to be marketed only under certain restrictions, which lower their selling price. The presence of the ticks also makes it impracticable to introduce a better class of cattle from noninfected sections.

For the past four years the United States Department of Agriculture, through the Bureau of Animal Industry, has been engaged, in cooperation with State and local authorities, in an effort to exterminate these ticks; and although this is a difficult undertaking, which will require many years for its successful conclusion, the progress so far made has already brought great benefits to the portions of the territory that have been freed from the ticks and has demonstrated that it is practicable in time to eradicate the ticks from the infested region. During the past fiscal year there have been released from quarantine as a result of the eradication of these ticks 57,520 square miles of territory, which is the largest area released in any year since the beginning of the work in the summer of 1906. The total area so released since the beginning of the work amounts to 128,856 square miles.

The rapidity with which this work can be carried forward depends on the amounts of money appropriated by the Federal and State Governments and upon the cooperation of the people of the affected region. The Federal appropriation for the past fiscal year was $250,000, and a like amount has been appropriated for the succeeding year. In order to use this money to the best advantage, the policy of the department is to operate only where State and local authorities are prepared to offer substantial cooperation and where public sentiment is favorable. During the calendar year 1909 the States and counties expended about $130,000 in this work, as indicated by reports received by the bureau; and as the work advances and its benefits become more obvious there is a disposition to increase the appropriations from year to year.

Besides the field work in exterminating the ticks by such methods as dipping, spraying, hand treatment, and pasture rotation, the bureau has continued the dissemination of information as to the nature of the ticks and the disease which they spread and as to advantages and methods of getting rid of them. Literature has been distributed, material has been furnished to newspapers, and lectures and

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addresses have been given at farmers' institutes and other meetings. A Farmers' Bulletin on "Methods of Exterminating the Texas-Fever Tick" was issued during the fiscal year and has been extensively distributed.

LIP-AND-LEG ULCERATION OF SHEEP.

The form of necrobacillosis known as lip-and-leg ulceration of sheep, which appeared in Wyoming about two years ago and became so threatening as to necessitate a Federal quarantine in the early part of the past fiscal year, has fortunately become much less prevalent under the quarantine and methods of treatment carried out under the direction and cooperation of Federal and State officers, aided, perhaps, by the drought of the past season. This disease appeared in a very malignant form over a large part of Wyoming and Montana, and it was necessary, before progress could be made in controlling it, to study more closely its nature and to work out methods of treatment. During the fall, winter, and spring three meetings were held at which officers of the bureau conferred with officers and sheep owners of the affected States to discuss the situation and consider means of dealing with it. A circular describing the disease and recommending methods of treatment was issued in the spring and has been widely circulated in the affected region. Ten veterinarians of the bureau's staff were stationed in different parts of Wyoming to observe the disease and to instruct and assist the flock masters in the best methods of treatment and in the disinfection of infected premises. Where care was exercised in administering the treatment and in disinfecting the premises the disease either disappeared or was greatly reduced. About one-fourth of the area placed under quarantine in the early part of the fiscal year was recently released, and the number of cases of the disease in the territory remaining in quarantine has been reduced about 50 or 75 per cent.

It has been thoroughly demonstrated that this disease can be controlled by methods such as have been adopted, although the malignant form is persistent, and very careful and thorough treatment is necessary. Numerous instances were found where flocks had become infected by being permitted to trail over ranges where diseased sheep had been and to drink at water holes where such sheep had watered. These instances, considered in connection with scientific experiments made by the bureau, show beyond question that the disease is of a contagious nature. While the majority of cases are of a mild type affecting only the lips, it seems that under certain conditions, which are not at present understood, this type may develop into the more severe form. In order to stamp out the disease, it is therefore necessary to treat the mild as well as the malignant form.

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SCABIES OF SHEEP AND CATTLE.

The eradication of scabies of sheep in the West has progressed so well that during the fiscal year areas aggregating 390,000 square miles were released from quarantine and the disease was greatly reduced in the territory remaining under quarantine.

During the fiscal year, owing to the continued increase of scabies in sheep in the State of Kentucky, the entire State was placed under Federal quarantine. On account of the absence of an efficient State law under which the bureau could cooperate, no active work in the eradication of the disease has been done. However, at the last session of the Kentucky Legislature an act was passed providing for the appointment of a State live-stock sanitary board with power to control and eradicate infectious and contagious diseases of live stock. Such a board was appointed June 15, 1910, the day after the law became effective. Arrangements have been made for the bureau to cooperate with this board in eradicating sheep scabies, and to this end active work will be commenced in the near future.

The area quarantined for scabies of cattle in the West was reduced during the fiscal year by the release from quarantine of more than 50,000 square miles.

ERADICATION OF BOVINE TUBERCULOSIS IN THE DISTRICT OF COLUMBIA.

During the past few years there has been a continuous and marked increase in private and legislative efforts to eradicate bovine tuberculosis. Coincident with these efforts on the part of States and municipalities, the Bureau of Animal Industry has given active aid toward the eradication of the disease in a number of localities and in preventing the interstate movement of cattle affected with tuberculosis. In the belief that a demonstration of the practicability of eradicating bovine tuberculosis from a given area would be of material benefit by the encouragement which it would give and by outlining working methods to accomplish successful results, the District of Columbia was selected for the purpose, and a cooperative arrangement was entered into with the Commissioners of the District.

All the cattle in the District, numbering 1,701, were tested with tuberculin, and of these 321, or 18.87 per cent, gave reactions. All of the reacting animals were slaughtered under inspection, and all except a few belonging to the Government were appraised and the owners reimbursed. In only five of the carcasses was there a failure to find lesions of tuberculosis on post-mortem, hence the correctness of the tuberculin reaction was verified in 98.36 per cent of the cases. Of course there is a likelihood that in these five cases the lesions were present but were too minute for detection by the methods used. In nearly 77 per cent of the carcasses the lesions were so slight and

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localized as to permit the use of the meat for food, while the remainder were more or less generalized cases and were entirely condemned. The average appraised value of the reacting cattle was $45.41. An average price of $18.88 was obtained from their sale, and the department reimbursed the owners to the extent of an average of $13.97 for each animal, making the average loss to owners $12.56 per cow, based upon the appraised value. The particulars of this work are given in the portion of this report relating to the Quarantine Division.

GID IN SHEEP.

Since the discovery of the gid parasite in sheep in Montana was announced by the bureau a few years ago the study of the gid disease and the parasite which causes it has been continued. One publication giving some of the results of this work was issued during the year and others are now in press and in preparation. As the disease appears to be prevalent only in a part of Montana, it is very desirable that the parasite should be prevented from spreading to other sections and that it should be exterminated if possible. To that end the bureau is endeavoring to place before the sheep owners of the affected region correct information as to the life history of the parasite, the nature of the disease, and methods to be followed in combating the parasite.

BREEDING HORSES FOR THE UNITED STATES ARMY.

Although horses are now commanding higher prices than have been known for many years, there is evidently a great shortage in their production. The United States Army has for some years found it difficult to maintain an adequate supply of suitable horses, and it seems that if the efficiency of the cavalry is to be maintained it will be necessary for the Government to take up some systematic plan to encourage the breeding of horses of a type suitable for Army use.

During the past year the Secretary of War requested the cooperation of the Secretary of Agriculture in evolving some plan for enabling the Army to obtain suitable horses. The Secretary of War pointed out that the supply of horses fit for remounts is becoming more and more limited, and that the present indications are that the country would find it impossible to mount its Army from its own resources in time of war, and is rapidly reaching a point where the needed supply of suitable remounts for the present strength of the Army would be extremely difficult to obtain, if obtainable at all. As a result this department designated a representative to join with a representative of the War Department in considering the subject and formulating a plan. The Department of Agriculture was represented by Mr. George M. Rommel, Chief of the Animal Husbandry

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Division of this bureau, and the War Department by Capt. Casper H. Conrad, jr., Third Cavalry, United States Army, detailed for duty in the Quartermaster General's Department in connection with the purchase of remounts. These gentlemen have outlined a plan for breeding horses for Army use, which plan is presented in the portion of this report dealing with the work of the Animal Husbandry Division. To carry out this plan would require appropriations for the use of this department estimated at $250,000 for the first year and $100,000 a year thereafter.

NEW EXPERIMENTAL FARM.

For several years the bureau has felt the need of a farm near Washington on which it could conduct experiments and investigations in breeding and feeding animals and in dairying, so that such work could be kept separate from that relating to infectious diseases as carried on at the Experiment Station at Bethesda, Md., as the work is so entirely different in character and is under the supervision of different divisions of the bureau. In the appropriation act for the Department of Agriculture for the fiscal year ending June 30, 1911, Congress appropriated $25,000 for the purchase of such a farm. The department purchased a farm of about 475 acres located at Beltsville, Prince Georges County, Md., about 13 miles from Washington. This farm is now being equipped for the purpose in view, and will be used by the Dairy and Animal Husbandry Divisions of the bureau. The work in the breeding and feeding of animals and poultry heretofore carried on at the Bethesda Experiment Station will be transferred to the new farm, and dairy work will be taken up later. The experimental work relating to diseases of animals will be conducted as heretofore at the Bethesda station.

NEED FOR ANOTHER ANIMAL QUARANTINE STATION ON THE ATLANTIC SEABOARD.

In recent years there has been a great increase in the number of imported animals subject to quarantine, and the capacity of the quarantine stations near the ports of New York and Boston has been overtaxed. This has caused considerable inconvenience to importers, some of whom have been compelled to defer shipments, awaiting the release from quarantine of other importations before space could be found for their importations. A number of them have diverted their animals to the Canadian quarantine station at Quebec.

There is great need for an additional quarantine station on the Atlantic seaboard, and this station should be located directly on the water front so as to be specially adapted to the reception of animals in cases where there seems to be more than ordinary danger of carrying infection. At the present time the bureau has no quarantine

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station on the water front. At New York transportation by barge from the steamer to the railroad on the New Jersey side is necessary, in addition to which 16 miles must be covered by rail before reaching the Athenia station. The quarantine of animals entering at Boston requires a railroad shipment of about 30 miles to reach the Littleton station.

As many importers have expressed their preference for the port of Baltimore as a quarantine station, on account of its being farther south than Boston or New York, thus having a milder climate, it is evident that if a quarantine station could be located on the water front near Baltimore, so that animals could be delivered by barge directly at the station from the steamer, such a station would not only receive its full share of patronage, but would increase the number of fine breeding animals imported into the United States, and would diminish the danger of the introduction and spread of contagious diseases.

NEEDED LEGISLATION.

SUPERVISION OF VACCINES, SERUMS, ETC.

In my report for the preceding year attention was called to the importance of investing the Secretary of Agriculture with legal power to control the importation of vaccines, serums, antitoxins, tuberculins, and other preparations sold for the detection, prevention, or treatment of diseases of animals, and to supervise the preparation of such products manufactured in this country for interstate commerce, such authority to be similar to that already vested in the United States Public Health and Marine-Hospital Service with regard to such products used in human medicine. A bill for this purpose was introduced in Congress, but was not acted upon at the last session. With the growing use of these remedies in veterinary medicine there is constant and increasing danger that contagious diseases may be introduced from abroad and spread in this country through such preparations unless their importation is properly supervised, and the facts reported last year show the necessity for the supervision of domestic preparations of this kind in order to protect our farmers, stock raisers, and veterinarians against fraudulent and unreliable preparations.

TRANSPORTATION OF LIVE STOCK.

Additional legislation by Congress is needed to enable the department to regulate more effectively the interstate transportation of live stock so as to prevent the spread of contagious diseases and provide more humane conditions.

Experience in the enforcement of what is known as the 28-hour law has shown the desirability of exempting from its operation

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live stock which is being shipped under quarantine restrictions. Owing to unforeseen delays it is sometimes necessary in order to comply with the law to unload stock which is being shipped under quarantine restrictions into pens which are not specially set apart for that class of stock and which are likely to be used soon afterwards for other stock, and in this way infection has sometimes been spread. This danger could be practically obviated if the Secretary of Agriculture were clothed with power in such cases of emergency to waive the provisions of the law so that animals under quarantine might be kept in the cars for a sufficient time to reach a point where facilities were available for handling them without danger to other stock.

Although existing law authorizes the Secretary of Agriculture to require the disinfection of live-stock cars moving into or out of a section that is quarantined, it is desirable to have this authority extended so as to empower the Secretary of Agriculture to require the disinfection of any live-stock cars used in interstate commerce whenever he may consider such disinfection necessary in order to prevent the spread of disease.

In the shipment of live stock it is sometimes a practice to put into the same car animals of various sizes and different species, with the result that small animals are often injured or trampled to death by larger ones. In order to remedy this evil it is desirable that the Secretary of Agriculture should have authority to regulate the shipment of different classes of stock in the same cars.

Dead animals are sometimes shipped in the same cars with live ones, and there is danger of the spread of disease in this way. Such shipments should be prohibited by law.

INTERSTATE SHIPMENT OF DAIRY PRODUCTS.

In my previous reports attention has been called to the need for inspecting dairy products and supervising their shipment. Cream is shipped great distances to creameries to be made into butter, and it is often received in such a filthy and putrid state as to be utterly unfit to enter into the composition of a food product. Even though Congress may not be ready to establish a comprehensive system of inspection for dairy products, much good could be accomplished by a law regulating the interstate shipment of cream and other dairy products so as to prevent interstate traffic in unwholesome products.

RENOVATED BUTTER.

At present the Bureau of Animal Industry supervises the manufacture of what is known as renovated or process butter and maintains inspection at the factories where it is prepared. This law has been found inadequate in some respects, and I consider it desirable to have

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it amended or superseded by a law containing provisions similar to those of the meat-inspection law, so far as they may be applicable, but retaining the revenue feature of the present law.

VETERINARY EDUCATION.

As stated in my last report, the courses of instruction in the various veterinary colleges in the United States were investigated by two committees, and certain recommendations as to requirements for admission to the civil-service examination for veterinary positions in the bureau were approved by the Secretary of Agriculture and the United States Civil Service Commission, to take effect September 1, 1909. Most of the colleges have been disposed to meet the requirements of the regulations in order that their graduates may be eligible to the bureau service, and there has already been considerable improvement in the courses and facilities at these colleges. The result is that not only is it possible for the bureau to obtain men better educated and qualified for its veterinary work, but the standard of veterinary education in the United States is being elevated.

PUBLICATIONS AND DIFFUSION OF INFORMATION.

The results of the bureau's work are made available to the people through publications, correspondence, public addresses, and material furnished to teachers, writers, and the press.

The bureau's new publications issued during the fiscal year numbered 89, aggregating 1,970 printed pages, besides which there were numerous reprints of earlier publications. The new publications consisted of the Twenty-fifth Annual Report of the bureau (for 1908), the annual report of the chief of the bureau for the fiscal year 1909, 12 bulletins, 15 circulars, 2 Farmers' Bulletins, 10 reprints from the annual report, 2 Yearbook articles, 29 orders and amendments, and 17 miscellaneous publications.

In addition to the distribution of literature it is necessary to conduct a heavy correspondence to meet the large volume of requests for information.

THE ANIMAL HUSBANDRY DIVISION.

The Animal Husbandry Office of the bureau was designated as the Animal Husbandry Division after January 1, 1910, by order of the Secretary of Agriculture. The work of the division is in no essential manner different from that of the Animal Husbandry Office. Mr. George M. Rommel has all along been in charge of this work, as animal husbandman during the first half of the fiscal year and as Chief of the Animal Husbandry Division since the establishment of that division.

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HORSE BREEDING.

COLORADO WORK.

The work in carriage-horse breeding at the Colorado Experiment Station has been much more satisfactory than during the previous year. There was no serious loss at foaling time and the foals are a very satisfactory lot. The foals by the stallion Carmon out of the mares purchased in Kentucky in 1908 are especially good.

The board of survey condemned 12 animals in August, 1909, all of which were removed from the stud. Two were destroyed (one for unsoundness and one for injuries) and the remainder sold. The mare Arba was injured in the pasture by cutting the tendons of the right hind leg just above the fetlock, and she was also destroyed. There were in the stud on June 30, 1910, 5 stallions in service, 31 brood mares, and 35 young animals; a total of 71.

A 2-year-old colt by the well-known Standardbred carriage stallion, Sir Walkill, jr., 32695, was bought in June, 1910, in Cedar County, Iowa, and will be given a trial at the stud. He is a very good individual and promises to develop into a good sire. He will not be available to outside mares until he has been given a thorough trial.

VERMONT WORK.

The work at the Morgan Horse Farm, Middlebury, Vt., is progressing satisfactorily, and each successive year's foals by General Gates show the wisdom of his purchase as the leading sire. The foals of 1909 (now yearlings) are a splendid lot and those of 1910 are equally promising. The only logical criticism which has ever been made of General Gates is that the Thoroughbred cross close up in his pedigree would make his get uncertain breeders. The use of Red Oak, a stallion sired by General Gates, is showing this criticism to have no foundation. Although Red Oak has not had severe service, he has produced a uniformly good lot of foals of a uniform Morgan type.

Purchases during the year were the brood mare Caroline by Daniel Lambert, and a yearling filly out of Caroline by General Gates. Caroline is the dam of Shakespeare, grand champion Morgan stallion at the St. Louis World's Fair; of Carrie Gates, first-prize 2-year-old filly at the same show; and of Helen, one of the most promising young mares at the Morgan Horse Farm. Caroline is now about 24 years of age and is still producing.

Three yearlings were disposed of at the close of the year and further culling will be done in the near future, some of the older stock being unsatisfactory for breeding purposes.

The following horses were in the stud on June 30, 1910: Stallions, 3; brood mares, 13; young animals, 14; total, 30.

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CLASSIFICATION FOR AMERICAN CARRIAGE HORSES.

The classification for American carriage horses recommended by the bureau in cooperation with the American Association of Trotting Horse Breeders has received a general acceptance by State fairs throughout the Central West. The showing of 1909 was more satisfactory than that of 1908, and considerably more interest was manifested by horse owners. The classification promises to become a permanent feature of State-fair premium lists.

SHEEP AND GOAT INVESTIGATIONS.

The work in range sheep breeding was continued during the fiscal year in cooperation with the Wyoming Experiment Station, but it has been found desirable for the department to carry on the work independently, and the arrangement with the station has been terminated. The experiment will not be removed from the State of Wyoming.

The methods of breeding have not been changed. Ewes that are short in fleece are bred to a Delaine ram, which shears a 3-inch staple. Ewes with folds or wrinkles on the neck are bred to a smooth-skinned ram in order to produce lambs that will be smoother than their dams. Ewes not especially well covered over the head and legs are bred to a ram especially good in this respect. Small ewes are bred to one of the largest rams. Ewes which show a tendency to coarseness of fleece are bred to a very fine-fleeced ram.

The lambing season the past spring was one of the best which we have yet had. Two hundred and eighty-three lambs were dropped, 149 ewe lambs and 134 ram lambs. At the time of sending the ewes and lambs to the range there were 243 lambs. Owing to the fact that we have had two very poor crops of lambs, which was due largely to the severe weather at lambing time on the range, it was decided last winter to bring the ewes in to the experiment station for lambing. This was done last spring, and the good lamb crop was the result.

The breeding ewes averaged 105 pounds in weight at shearing time and sheared an average of 10.6 pounds of wool. The yearling ewes weighed an average of 73.8 pounds and sheared 7.31 pounds. The rams sheared an average of 14.2 pounds per head. The wool was graded as follows: Twenty-six fleeces as fine, 240 fine medium, 79 medium, and 1 low medium. The ram fleeces were graded as 1 fine, 2 medium, and 5 fine medium. The condition of the wool was given as follows: Sixty-two fleeces were in poor condition, 2 in very poor condition, 139 in fair condition, and 129 in good condition. The fleeces of the ewes averaged 2.27 inches in length.

Ever since the acquisition of the Morgan Horse Farm the idea has been kept in mind that a flock of sheep should be maintained there

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for their beneficial effect on the land, but principally to encourage New England farmers to return to sheep raising. A few head of registered Southdowns have been kept for some time, and last fall 30 ewes and a buck were purchased from one of the best flocks in Canada. An old barn has been rebuilt for a sheep barn and a shepherd engaged. Rams will be sold during the early fall after they are 1 year old, and every effort made to assist in building up the sheep industry of New England. Last spring 32 ewes dropped 43 lambs.

The flock of sheep at the Bureau Experiment Station at Bethesda, Md., comprises 21 head of Delaine Merinos, 50 Barbados, 8 crossbred Merino-Barbados, and 4 the progeny of crossbreds. The Delaine Merinos will be used for some wool experiments during the coming year. A number of Barbados ewes will be bred to a Southdown ram for the production of early lambs. Owing to the fact that these ewes are especially good milkers and will breed any time of the year, it seems that they should be valuable for crossing with mutton rams for the production of early lambs.

At the present time the bureau has a flock of 38 milch goats—22 old does, 5 yearling does, 8 kids, and 3 bucks. During the past kidding season we have not had very good results with the goats, as 26 of the 33 kids dropped had goiter. At the close of the fiscal year 18 does were being milked, and samples of the milk were being tested for butterfat and subjected to chemical analysis.

CATTLE BREEDING.

HOLSTEIN CATTLE.

A field superintendent for the Holstein cattle work in cooperation with the North Dakota Experiment Station began work November 15, 1909, the first work undertaken being to test all the cattle in the herd of each member of the circuit for tuberculosis. Only 4 head reacted in 400 tested. Two head of the four reactors were purebreds that had been brought in from other States for the circuit work and had been bought subject to the test. The other two were grades that had been in the herds some time.

On January 1 arrangements were made for keeping the record of milk and fat produced by each cow on the circuit. The milk of each cow is weighed at each milking, and the field superintendent visits each farmer once a month and makes a fat test of the milk of each cow. The cost of the feed is also being determined as closely as possible.

The breeding, feeding, and general care of the cattle in the herds are closely watched, and the superintendent gives advice on these points during his monthly visits.

Several meetings of the members of the circuit association were held during the year for instruction in better methods of feeding and

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management. The use of silos is being especially emphasized. Members of the experiment station staff have assisted at these meetings. The members of the circuit and farmers of the surrounding country and of the State as a whole have taken a great deal of interest in the work of the circuit. The purebred Holsteins of all ages in the circuit number 71 head.

In the near future it is expected to test some of the promising cows and heifers for the advance registry of the Holstein-Friesian Breeders' Association. The herds will be carefully culled during the year and the culls replaced with new purchases.

MILKING SHORTHORNS.

There are now four herds in the circuit for the breeding of milking Shorthorn cattle in cooperation with the Minnesota Experiment Station. During the year one herd was dropped from the circuit, and one herd was added. The feeding and general management of the herds has been materially improved, and more careful records have been kept. Two of the cooperators are now putting up silos.

The two sires, Chief of Glenside 285899 and Beau of Glenside 285898, are now past 3 years old. In addition to what is known of the general high standard of the milking heredity of these bulls, their value from this standpoint has been much enhanced during the past year by the record of 18,000 pounds of milk and 735 pounds of butter made by Rose of Glenside, the dam of Chief of Glenside and the half-sister of Beau of Glenside. These bulls are now being used entirely on the circuit. They have sired several yearlings and about 20 calves dropped in the fall of 1909 and spring of 1910. These are a thrifty, rugged lot and give promise of growing into very good cattle.

All heifers produced by approved dams will be reared to maturity, when they will be tried out at the pail. Their milk production in connection with their general conformation and breeding power will then determine their value to the project. The bull calves are being reared, and at 8 to 12 months old will be divided into three classes—reserved, approved, and rejected. All bull calves rejected will be sold for slaughter, those approved will be sold to breeders in the usual way, and those reserved will be kept for use on the circuit.

The cows on the circuit are largely the same as last year except some heifers that have matured and a few cows that were purchased in the East. Four cows purchased in New York and Pennsylvania have been added to the experiment station herd.

Three heifers of the same breeding have also recently been purchased for one of the herds in the circuit. They are all in their first period of lactation and give indications of proving to be good producers.

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During the past year there has been much inquiry and a rapidly increased demand for Shorthorns that will milk profitably. The cooperators have had no females and few bulls to sell. The majority of buyers are demanding milk records and apparently becoming more discriminating in their selection of breeding animals.

ANIMAL BREEDING INVESTIGATIONS.

During the past year the breeding experiments which have been under way at the Bureau Experiment Station at Bethesda, Md., were continued and valuable data are being obtained.

The results of the zebra hybrid breeding work have been fully described in an article submitted for publication in the Twenty-sixth Annual Report of the bureau.

The inbreeding experiments are making satisfactory progress. Data have been obtained from about 5,000 guinea pigs during the past year. Complete results of the work can not be reported until later. A race of polydactylous guinea pigs has been established by selecting sports having this peculiarity for foundation stock.

The results obtained from the rat-breeding work have verified Mendel's law of heredity so far as coat color is concerned.

POULTRY INVESTIGATIONS.

MAINE WORK.

The detailed intensive study of inheritance of egg production or fecundity in the domestic fowl in cooperation with the Maine Experiment Station has gone forward satisfactorily during the year. By the plan of selection now being practiced it has been possible to isolate from the flock strains or "blood lines" which are breeding true to definite standards of egg production. There are now being propagated (*a*) lines having a high winter egg production, (*b*) lines having a medium degree of winter productiveness, and (*c*) lines of low winter production. The results which have been obtained in this work are of a definite character and are believed to be of fundamental significance, not only in relation to breeding for egg production, but also in relation to the broader problem of breeding animals for production in general, whether of meat, milk, or other desirable qualities.

The experiment in breeding hybrid poultry from Barred Plymouth Rocks and Cornish Indian Games is progressing well. By the application of the Mendelian principles it has been possible to combine in one strain the good meat quality of the Cornish Indian Game with the good laying quality of the Barred Plymouth Rock. The new type thus created seems to be a very desirable one from the utility standpoint. The study of egg production of these hybrids has resulted in

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bringing to light important evidence regarding a type of inheritance—sex limited—hitherto but little understood.

In connection with the work in breeding for egg production a detailed study of factors influencing the fertility and hatching quality of eggs has been made, which shows that this quality is a definitely inherited character which may be improved by selective breeding.

In general the plans for the future contemplate a continuance and further development of the work already under way.

INDEPENDENT INVESTIGATIONS.

During the year the poultry investigations at the Bureau Experiment Station have been continued. The comparison of the dry and moist mash and the hopper systems of feeding, begun in the fall of 1906, were brought to a close in the fall of 1909. This work has been carried through the three years, and three successive generations of fowls have been used. The results have been so variable that no definite relation between egg yield and method of feeding has been established.

During the year a feeding test was begun with cottonseed meal to see whether it had any harmful effect on laying hens. Five pens of fowls were used in this test. In addition to a grain ration, which each pen received, there was fed to one pen a mash containing about 30 per cent of cottonseed meal, and to another a mash containing about 18 per cent; and there were fed to the other pens, as checks, mash containing from 12 per cent to 40 per cent of linseed meal. The mash containing 30 per cent cottonseed meal was as rich a cottonseed mixture as the hens would eat readily. This experiment has been running six months and no harmful effects which can be attributed to the cottonseed meal in the ration have been noted.

A short experiment to determine the palatability of soy beans and cowpeas as a feed for laying hens was carried on. Three pens were used, each receiving in addition to their mash a grain feed composed in the check pen of equal parts of wheat and whole corn, and in the other pens cowpeas and soy beans in place of the wheat. After a few days both the cowpeas and the soy beans were eaten readily and apparently relished. The hens seemed to do quite as well on the cowpeas or the soy beans as on the ration containing wheat.

During the winter dried beet pulp was tried to some extent as a green feed. This material furnished a green feed which seemed to be quite palatable, cheap, and generally satisfactory.

The work at Bethesda has been greatly handicapped by the reappearance in the flock of coccidiosis or white diarrhea, the disease which caused so much trouble last year. This has rendered it impossible to rear satisfactory young stock, those escaping death being stunted and entirely unfit to save for breeding purposes. The effect

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of the infection is also apparent in the old stock, causing an abnormally high rate of mortality, greatly reducing the vigor and the egg yield.

During the year plans have been perfected for following up the investigation of the methods of handling eggs. A preliminary survey of this field had previously been made, and the information thus obtained is to be followed up by field work. The plans contemplate the prosecution of this problem by this bureau in cooperation with the Bureau of Chemistry. The source of production of the eggs, methods of feeding the hens, conditions under which the eggs are produced, and the various steps and conditions in the handling of the eggs till they reach the packing house will be studied by this bureau. From that point onward, through cold storage or without it, to the ultimate consumer, the eggs will be followed by the Bureau of Chemistry. There is good ground for the belief that an investigation of this character will result in a cutting down of much of the present waste and deterioration due to careless or ignorant methods and will eventually mean a greater return to the producer and a better average quality of eggs produced in the summer and fall months without added cost to the consumer.

ANIMAL NUTRITION.

The experiments in cooperation with the Pennsylvania State College have been conducted during the past fiscal year for the purpose of ascertaining the feeding value of hominy feed, a by-product of the manufacture of hominy from corn, concerning which little accurate information is available. A comparison was made of this feed with the corn from which it was manufactured, and incidentally the energy values of mixed clover and timothy hay were also included in the investigation.

BEEF PRODUCTION INVESTIGATIONS.

Investigations in beef production have been in progress for six years in cooperation with the Alabama Experiment Station, and results are being obtained which indicate not only that cattle may be profitably fed in the South, but that the South offers an excellent field for the extension of the beef-producing area of the country. During recent years these investigations have been confined to Sumter County, and the work has been done under the supervision of Prof. Dan T. Gray, of the Alabama Experiment Station, directly with farmers who furnish the cattle, the feed and pasture, and all buildings and equipment. The department and the Alabama Experiment Station furnish the men to carry on the work. One assistant has been stationed at each farm, who usually selects the cattle and feeds them.

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Until the last fiscal year this work was done with only one cooperator on two farms, but last year another cooperator was added in the same county.

The following questions are being studied: Methods of carrying mature beef animals through the winter months with the object of fattening them on pasture the following summer; methods of carrying calves through the winter months with the object of finishing them the following summer or fall; to determine the profit, if any, in supplementing the summer pasturage with certain cotton by-products in finishing cattle for the summer or fall markets; to determine the most profitable amount of cottonseed cake to feed steers where they are being finished on pasture for the market; to compare silage, cottonseed hulls, and Johnson-grass hay as feeds for finishing steers in winter time; to determine the value to the soil, as measured by succeeding cotton crops, of feeding cattle upon that soil.

Results, so far as the work has progressed, have been prepared for publication. They show that while winter feeding may be sometimes done fairly economically, summer feeding on grass has been found most profitable. For example, during the summer of 1909 cattle were fed on pasture alone at a cost of $1.03 per 100 pounds gain, on pasture and cottonseed cake at a cost of $3.21 per 100 pounds gain, and on pasture and cotton seed at a cost of $2.39 per 100 pounds gain, the profit per steer on these lots being $7.06, $6.99, and $8.39, respectively. A lot fed a shorter time on a ration of cottonseed cake considerably heavier than that noted above cost $2.70 per 100 pounds of gain, with a profit of $10.64 per head.

When it is considered that these profits were made by feeding the cattle alone, without hogs to follow the steers, it is apparent that there is an undoubted future before the beef-cattle industry in the South. There are large areas in the South well adapted to profitable beef production and where no cattle are now fed. There are therefore great possibilities before the South to add to a beef supply that is rapidly decreasing in relative if not in actual ratio to the country's increase in population.

During the fiscal year 1911 an investigation will be made into the problems underlying the shrinkage of beef cattle in shipment, both from the range and from the corn belt.

PORK PRODUCTION INVESTIGATIONS.

During the fiscal year just ended studies in pork production were established at one of the farms in Sumter County, Ala., where beef work is in progress. The object of this work is to carry out under farm conditions some of the conclusions that have already been drawn by the Alabama Experiment Station, and to determine the profits that can be realized upon a herd of hogs when fed and handled

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in a businesslike manner. In doing the work a complete record is kept of the expense of making the various forage crops, the amount of concentrated feeds given all hogs, the gain in weight, etc. In July, 1910, there were 138 hogs in the test. This number will be increased as time goes on. Purebred boars are being used with ordinary sows.

SUPERVISION OF PEDIGREE RECORD ASSOCIATIONS.

The investigation of the draft-horse studbook, referred to in my last report, was completed during the year, and the society publishing the book was given two hearings before the department. In general, it may be said that as a result of the conditions disclosed by this investigation it has become necessary for the department to exercise the power given to it by the tariff law to pass upon the sufficiency of the pedigree certificates of animals imported for breeding purposes, instead of delegating this function to certified American pedigree record associations, as has been the policy heretofore.

There were on the department's list of certified pedigree record associations at the close of the fiscal year 135 books of record, of which 66 were American and 69 foreign.

BREEDING HORSES FOR THE UNITED STATES ARMY.

The question of breeding horses for the United States Army has been discussed briefly in a previous portion of this report. The following discussion, presenting more in detail the difficulty of obtaining suitable horses for Army use, the great need of Government encouragement of breeding such horses, and a definite plan for accomplishing the desired object, is the result of the joint consideration of the subject by representatives of the Department of Agriculture and the War Department at the instance of the Secretary of War. As before stated, the Department of Agriculture was represented by Mr. George M. Rommel, Chief of the Animal Husbandry Division of the Bureau of Animal Industry, and the War Department by Capt. Casper H. Conrad, jr., Third Cavalry, United States Army, detailed for duty in the Quartermaster General's Department in connection with the purchase of remounts. The statement setting forth the reasons why the War Department regards it as imperative for the Government to undertake the work of encouraging the breeding of horses for the Army was prepared by Capt. Conrad and is inserted here with the consent and approval of the Quartermaster General. The plan for breeding the horses was prepared by Mr. Rommel with the assistance of Capt. Conrad and other officers of the Army stationed in Washington, and has been formally approved by the War Department.

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THE NECESSITY FOR GOVERNMENT ENCOURAGEMENT OF BREEDING ARMY HORSES.

The difficulty experienced by the Quartermaster's Department in procuring remounts seems perfectly natural. The early settlement of the United States, particularly the eastern part, went on some time before the advent of steam and electric transportation, and the settlement of the western part even now in the most remote points takes place without the assistance of modern transportation. In all new countries the horse has played an important part in the advancement of civilization and the general scheme of settlement. Even in the first part of the nineteenth century the horse was a very much more important animal in Europe and the British Isles than at present.

During the opening of a country the settler must, owing to the absence of roads and other forms of transportation, put his principal reliance upon the horse; he is forced to travel trails and long distances, and for this purpose finds that he needs a horse suitable to carry him quickly and comfortably to his destination. To accompany him and carry the articles necessary for his daily life he needs a pack animal. So long as conditions remain unchanged, a desirable type of saddle and pack animal will exist in good numbers; but so soon as the country becomes more settled and habitations more permanent, the mountain trail gives place to the road, and later the country road to the worked and metaled highway, and the type of horse rapidly changes. The necessity for the saddle animal lessens; the light-draft animal becomes more important; the people ride less and discard the expensive pack transportation; the horse is attached to a light vehicle with which he is able to transport more than one person or a heavier load. As the roads become better and the country more extensively cultivated the lighter horse is used more for pleasure or solely as a means of drawing the carriage; another type of horse becomes more useful and economical, and the light-draft type appears to be succeeded by the heavy draft. Next come the railroad, the trolley line, and the automobile. The people ride and drive less, and fewer horses of the riding types are bred. Riding is indulged in almost solely for pleasure. A new country is a country on horseback; an up-to-date one, a country in an easy chair.

In the United States the type of horse suitable for Army purposes is now proportionately less numerous because it is not found necessary to the civilians of the country, and the Quartermaster's Department is finding it each year more difficult to supply the yearly demands of the mounted branch of a small army.

The horses of our mounted branches are severely criticized by representatives of foreign armies, while from our own officers come reports of poor animals, poor performance, many quickly developed unsoundnesses, and short life.

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As an illustration, in the West it is found that a marked change has taken place in recent years in the so-called "cow pony." Twenty years ago cattle ranches of the West were practically without fences and unlimited, and the cowman found it necessary to breed and use a type of quick, active pony. As the West became settled and as agriculture was taken up the large free ranges changed to the large fenced pastures of a few years ago. These large pastures are now being broken up into even smaller ones. The yearly round-up requiring riding over immense distances and active work has about disappeared. To-day cattle are not chased and roped, but are driven into the small pastures and pens and quietly handled. The quick cow pony of the past has given place to a larger animal, frequently having a cross of draft blood. It may be said that the cow pony of the West has practically disappeared.

Virginia has long been famous for the horse known as the Virginia hunter. Even the breeding of this type of horse has been sadly affected by the high price of heavy-draft horses and further influenced by the fact that only those hunter-bred horses that attained full size brought high prices. Under the haphazard methods of breeding in vogue in these sections not more than one in six colts could be depended upon to attain the size necessary to bring a high price, and the farmer found himself the possessor of four or five small horses for which there was no steady market. When he found that all draft colts, in spite of minor blemishes, brought good prices as 3-year-olds, he at once ceased to breed the hunter type, with its many misfits, and commenced on heavy draft horses. The disappointment in the hunter-bred horse would not have been so great had the breeding of this type been done scientifically and rationally. The hunter-bred horse as now raised in Virginia is sired almost entirely by stallions either sent to the country gratis or sold at small prices to individuals by wealthy people in the North, who desire hunters and are looking to the future supply. A farmer living in the neighborhood of a thoroughbred stallion and feeling that he would like to breed a hunter will take advantage of the nearest and cheapest stallion in his neighborhood, regardless of what the result may be. All that he considers necessary is that the horse should be, first, a thoroughbred, and, second, that he should be a pleasing individual, never taking into consideration the fact that the mare might not be suited to the horse nor the horse to the mare. Hence the misfits, the discouragement, and the decrease in number of the hunter type. It is said that not one-tenth as many hunters are bred in Virginia to-day as formerly.

Even more appalling than the present scarcity of horses suitable for military purposes in this country is the large number of unsound horses that are constantly being examined by purchasing officers. Horses of this class can be the result of but one thing, and that is

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an absolutely irrational system of breeding, or the lack of any system whatsoever. When it is remembered that a sound and serviceable horse of a particular type costs no more to raise than an unsound horse, the immense waste caused by our present lack of system is only made more apparent.

The enactment in a number of States of laws whose effect is to prohibit the standing of unsound stallions for public service will no doubt, in time, tend to correct this evil; but not until the horse-raising States generally prohibit absolutely the public stud service of unsound stallions will unsound horses be less common on the market. Such legislation in one State is an excellent thing for that particular State, but it is very likely to drive all the unsound stallions across the borders into adjoining States where laws against the unsound stallion do not exist.

The next census will probably show that there are in the neighborhood of 23,000,000 horses in the United States. It would seem that in this immense number there must be many thousands of horses suitable as remounts for the Army, and there probably are; but the fact that the type desired is comparatively scarce, and that the horses that would do are scattered over an immense area and are in demand for other purposes than the military, makes it not only expensive and impracticable to obtain them, but next to impossible to do so.

The purchase of young horses for the Army during the last fiscal year has been more or less successful, but all officers connected with the Quartermaster's Department have reported that while they were obtaining a fair number of horses, they could see no prospect of obtaining them in any number in future years, and all report the apparent necessity for the Government's assistance in the rational breeding of Army horses in the country.

As no system of supply, so far as the Army is concerned, which deals with peace conditions alone, is complete, the War Department must constantly keep in mind the possibilities of war, and it is not surprising that, finding difficulty in purchasing a supply of remounts for the peace Army, there should be more or less uneasiness when war requirements are considered.

The waste of horseflesh in war times is enormous, and in a war of any magnitude in which this country might be engaged the number of horses required will not be confined to the thousands per year, but will extend into the hundreds of thousands.

In this connection attention is invited to a few of the records on this subject:

There were purchased for the armies of the Federal Government in the fiscal year ending June 30, 1864, 188,718 horses. There were captured from the enemy and reported 20,388. Leaving out of consideration those captured and not reported, it should be observed that the Army required 500 horses each day

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for remounts. This, therefore, is the measure of destruction of horses during the same period.

During the eight months of the year 1864 the Cavalry of the Army of the Potomac was supplied with two remounts, nearly 40,000 horses. The supply of fresh horses to the Army of Gen. Sheridan during his campaign in the Valley of the Shenandoah has been at the rate of 150 per day.

During the Russian campaign the French crossed the Nieman in June, 1812, with cavalry, artillery, and train horses to the extent of 127,121. About 60,000 of these pertained to the Cavalry. On December 13 the remnant of the invading army recrossed the Nieman with 1,600 cavalry horses. In six months the horses had all disappeared.

Examples of the terrible waste of horseflesh during war might be multiplied ad libitum.

The questions of remounts for the Army became so serious during the Civil War that in 1863 the cavalry bureau was established. One of the principal duties of this bureau was the purchase and inspection of horses for the Army. Six remount depots were established. The most important of these was Giesboro Manor, situated on the north bank of the Potomac, nearly equal distance between Washington and Alexandria. To show the magnitude of operations of the cavalry bureau, the following report of the Giesboro depot is given:

On hand Oct. 1, 1863, Cavalry horses	4,281	
Received to Dec. 31, 1863	36,932	
Total		41,213
Issued	22,204	
Sold	1,651	
Died	1,637	
Total		25,492
On hand Jan. 1, 1864		15,721
Received by purchase, Jan. 1, 1864, to June 30, 1866		5,326
Received from other depots for issue		59,507
Received for recuperation		85,980
Received by transfer from Artillery		4,120
Total		170,654
Issued to armies in the field	96,006	
Issued to officers after June 30, 1865	1,574	
Issued for sale or sold at depot	48,721	
Died	24,321	
Total		170,622
On hand June 30, 1866		32

This does not take into consideration the twelve or thirteen thousand Artillery horses handled at this depot.

This report closes with the abandonment of the depot, but it is to be remembered that nearly all the Volunteer Cavalry was mustered out immediately after the surrender of Gen. Lee's army the preceding

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year, so that nearly all the horses were handled during a period of 18 months.

Until recently acts of Congress appropriating money for the purchase of horses for the Army required that they should be purchased by contract from the lowest responsible bidder, after advertisement. The specifications of the horse to be delivered under contract are those of a perfect animal, which, of course, is seldom seen. The inspectors and purchasing officers are required to reconcile these specifications with existing conditions, keeping in mind fairness both to the contractor and to the Government. This system led to the building up of the class of middle men who purchased animals from the breeders, presented them for the action of the Government inspectors, and sold them at the contract price. Until recently this price ranged from $100 to $150. Considering the large expense to which the contractor would be put, it could not be expected that all of the Government's money would be invested in horseflesh. The result was, considering the profit by the contractor, his expenses, etc., that the price paid by the Government secured for the Cavalry a horse worth from $70 to $100. Nothing is known of the breeding of these animals further than that they were "probably of such and such breeding." Often the question of breeding was not raised, the principal requisite being that they should give promise of performing the duties expected of them.

The contract system has tended to discourage the horse breeder of the country, as the money paid him by the contractor, after much haggling, was often very little more than the cost of raising the horse. There has been no incentive for breeders, even in the best naturally endowed sections, to breed the type of horse that the Army needs.

Again, in recent years the demands for heavy draft animals for farming purposes, the high prices that these animals are bringing, the fact that they cost no more to raise, and bring even a higher price although blemished, has had a further bad effect upon the breeding of the desired saddle type. Even before the present high prices of all horses and the higher price of the draft horse existed, the breeding of the type considered best for Army purposes received another severe setback by the adoption of electric and cable street railways and the extension of the trolleys. While not generally appreciated, the best "railroaders," as the horses used for street cars were called in the market, were the very kind that makes the best cavalry mount. This horse was desirable for street-car purposes because of his endurance and his willingness to work.

The contract system received its first serious setback, from the contractor's standpoint, when the Army, due to the clamor for better mounts, insisted upon a closer compliance with the contract specifica-

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tions and rejected more of the horses presented by the contractor. The sudden rise in the price of horses further embarrassed the contractor, and the added difficulty of obtaining horses to present for inspection caused many of the contractors to fail in their deliveries, made others reluctant to bid, later led to the impossibility of obtaining horses under this system in certain sections, and finally led to authority being given by Congress for open-market purchases. This method, while apparently a little more expensive to the Government, had the advantage of eliminating the middle man, giving the breeder all the money which the Government was willing to pay for horses, and giving the Government value received in horseflesh.

The establishment in 1908 of the remount depots has further improved the type of horse for the Army, as the system of purchasing young horses 3 and 4 years old, often unbroken, has enabled the Government to get the best type of horse before he has cost the breeder much money and when he could be sold for a reasonable amount. These horses, sent to the depots for maturing and handling, and finally issued to troops as 4½ and 5 year olds, while costing the Government more per head than the horses 5 and 6 years old formerly purchased and issued directly to troops, are very much better horses from the beginning, are properly developed at a critical period in their existence, rationally handled, and, when issued to troops, have been received with enthusiasm as a great improvement over the matured horses formerly issued under the old system. Even considering the high market value of horses at present, it is believed that, under the remount system, horses can be issued to troops at not to exceed a total average cost of $225. The latest contract price of Cavalry horses is $183.75; for Artillery horses, $213.75. Many of the late contract horses are young and require some handling at depots before suitable for service; others are mature.

Horses purchased as mature under the old system have had a useful life in the Army of 6.4 years on an average. The better grade of horses, such as are now being purchased, rationally developed and handled, should and will have a useful average life of 10 years. It is easy to see that the better horse issued from the depot at a cost of $225 that lasts 10 years is cheaper than the horse costing from $183 to $213 lasting only 6.4 years. In addition the Army will have had a better horse throughout the entire period of usefulness. The horses being issued from the depot could undoubtedly be sold at time of issue at a handsome profit. Many individuals would bring fancy prices. It is needless to say that if it were possible to purchase them in issue form, it would be necessary to pay much more than they have cost under the depot system.

European countries long ago found it not only advisable but necessary to supervise the breeding of horses in order to supply the de-

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mands of their armies, and every European country of importance, with the exception of England, has for years been encouraging the breeding of the proper type of army remount. England, one of the most important horse countries of the world, has for many reasons only recently been forced to this step. It is interesting to note that practically the same conditions confront England that confront this country at the present time, and that almost identical steps are contemplated in the two Anglo-Saxon countries to accomplish the same result—suitable army horses in sufficient number.

A Plan for Breeding Horses for the United States Army.

NUMBER OF STALLIONS REQUIRED.

From the best information available it would appear that a comprehensive plan to breed the horses needed for the mounted service of the Army on the present peace footing should provide for not less than 2,000 horses a year and need not exceed an estimated allowance for over 2,500 a year.

To determine the number of stallions needed for this work, allowances must be made for failure of stallions to get in foal all mares served, for ordinary losses of foals, and for failure of foals bred to prove suitable for remounts.

A good sound stallion will get about 75 per cent of his mares in foal. Of the resulting foals an average of at least 10 per cent will die from various causes before they are old enough to be purchased as remounts. In the proposed Army horse-breeding work probably about 50 per cent of the remainder would be suitable for remounts.

Based on an estimate of 100 stallions, the following results could be expected for varying numbers of mares served by each stallion:

Number of mares covered by each stallion.	Estimated number of suitable remounts by 100 stallions.
40	1,350
50	1,688
60	2,025
70	2,363

An estimate of 100 stallions would therefore appear to be conservative. It is doubtful if stallions average more than 70 mares a season, as a rule. In some localities it would probably be possible to stand stallions for a short fall breeding season in addition to the usual spring season, in which case a larger number of mares could be covered. In others only a spring season would be feasible, and a smaller number of suitable mares might be offered.

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DISTRIBUTION OF STALLIONS.

The country should be divided into four or more breeding districts, as follows, and stallions assigned as indicated:

New England district (vicinity of Maine and New Hampshire)	10 Morgans.
Central district (Virginia, West Virginia, Kentucky, and Tennessee, with perhaps certain sections of Indiana and Ohio).	30 Throroughbreds. 10 Standardbreds. 10 Saddlers.
Southwestern district (vicinity of Missouri or Texas, with perhaps certain sections of Iowa).	5 Thoroughbreds. 5 Saddlers. 5 Standardbreds.
Northwestern district (Montana, Washington, Oregon, and perhaps California).	15 Thoroughbreds. 10 Standardbreds.
Total	100

It might be well to subdivide one or more of these districts. The above arrangement is worked out to establish such districts so that they will be in reasonable proximity to Government stations where the stallions may be kept between breeding seasons.

NUMBER OF REMOUNTS AVAILABLE ANNUALLY.

Based on the foregoing estimates, the number of remounts available yearly from these sections would be as follows, with stallions covering the maximum of 70 mares, and taking 24 as a convenient unit for the number of suitable remounts got by each stallion annually:

New England district	240 Half-Morgans.
Central district	720 Halfbreds. 240 Half-Standardbreds. 240 Saddlers.
Southwestern district	120 Halfbreds. 120 Saddlers. 120 Half-Standardbreds.
Northwestern district	360 Halfbreds. 240 Half-Standardbreds.
Total	2,400

A considerable number of the horses sired by the Morgan and Standardbred stallions would be suitable for cavalry remounts, but a much larger number would be preferable for the field artillery. The number of estimated remounts by Morgans and Standardbreds is 840. In selecting stallions of these breeds, due consideration should be given the necessity for artillery remounts.

SELECTION OF BREEDING DISTRICTS.

Those localities should be selected for breeding districts where conditions are especially suited to horse raising, where the type of mares is most likely to approach the type of horses desired for the Army,

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where a light type of horse will always in the long run be the most profitable to the farmer and draft horses least likely to gain a firm foothold, and where mares are sufficiently numerous to give the stallions maximum service. A careful survey of the horse-raising districts of the country will be necessary before this question is settled, and the returns of the Thirteenth Census can probably be used. The Bureau of Statistics of the Department of Agriculture states that it is impossible to use its returns for this purpose. Perhaps, however, that bureau could assist in making the survey.

The Government reservations where stallions would be kept between the breeding seasons would be the points around which the work would center. In some cases it might be possible to stand some stallions on the central station itself. Stallions should be distributed in lots of five around the central stations, and such further distribution could be made as necessity required. At the close of the season they would be returned to the central station and kept there until the next or sent to another locality.

THE EXPERIMENTAL FEATURE.

The plan has experimental possibilities of the highest order, which should be utilized. The leading features are the test of the value of different breeds to produce remounts and the value of different soils and climates for the purpose, which could soon be determined by the Army by keeping records of performance. Certain troops, squadrons, and batteries, and entire regiments, could be supplied with remounts bred in a certain way in certain localities, and the possibilities of the plan from an experimental standpoint would thus become very great. By the time a second large appropriation to purchase stallions would, if ever, be necessary, the Government would be in possession of facts which would enable it to show definitely whether the plan had been successful, and whether any crosses or localities should be eliminated from further consideration. It might be well, also, to consider the feasibility of arranging with the breeders to reserve a small number of high-class fillies each year for breeding purposes; otherwise mare owners would be compelled to replace their mares by purchase, which would bring the problem little nearer solution at the end of 20 or 50 years than it was at the beginning. That it is possible in time to fix the type desired for remounts is by no means questionable, and this may indeed be very desirable.

TERMS OF SERVICE.

No mare should be bred to a Government stallion until she has been approved by the proper officer as of the type suitable to produce remounts. The common unsoundness, the tendency to which

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be transmitted from one generation to another, should naturally disqualify a mare, but even more important would be the necessity to refuse a mare on account of manifest faults of conformation, action, or quality.

The terms of service should be free, the owner of the mare entering into a contract to give the War Department an option on the resulting foal during the year it is 3 years old (estimating a horse to be 1 year old on the 1st of January after it is foaled) at a price to be fixed before the mare is bred. A provision should be included in the contract that the mare must remain in the owner's possession until the foal is weaned, and that, in case the foal is sold before the War Department has exercised its option, a service fee shall be exacted from the breeder of the foal. Provision should be made, however, to cover such emergencies as the death of the breeder, etc.

The price contracted to be paid for remounts should be fixed annually for each State by a board of arbitration before the breeding season opens, subject to the approval of the Secretary of War. For example, in January or February, 1912, this board would meet in each State mentioned above and agree upon the price to be paid for remounts bred in that State to be purchased in 1916; in 1913 prices to be paid in 1917 would be fixed, and so on. The arbitration board should be composed of an officer of the Army, an officer of the Department of Agriculture, and a citizen residing in the State, preferably a competent horseman. In purchasing remounts, no discrimination should be made against mares; colts should have been castrated at the breeder's expense, preferably between 1 and 2 years of age.

ORGANIZATION.

The breeding work would be administered by the Bureau of Animal Industry of the Department of Agriculture through the Chief of the Animal Husbandry Division. This division would direct the work under the supervision of the chief of the bureau, and keep the breeding records and the reports on the development of the foals. Not later than January 1 of each year it should furnish a report for transmission to the War Department on the actual number of 3-year-olds in each breeding district available for purchase during the year and the probable number of these that will make satisfactory remounts. A competent animal husbandman should be employed, with headquarters at Washington, as a traveling inspector of breeding stations, to keep the department in close touch with the work in addition to receiving regular reports from the breeding districts.

The men in charge of the breeding districts should be obtained from the field force of the Bureau of Animal Industry. These men should be good veterinarians, with a thorough knowledge of horse

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husbandry. Their field experience would make them invaluable for this work, and the loss to the field service of the bureau would be more than compensated by the fact that they could handle the work better than any men who might be obtained from the outside. If the Government undertakes this project it must do so under the most favorable auspices, and no risk of failure should be run. As success would largely depend on the ability of the men in charge in the field, the best men available should be obtained. The expert assistants to men in charge of breeding districts should be animal husbandry graduates of agricultural colleges, and not veterinarians. This would balance the service in a very effective way.

The duties of these men would be to direct the work at the breeding stations in their districts, to attend to the keeping of the records, to advise mare owners on the care of horses, and, if possible, to travel through their districts before the breeding season opens and approve mares, directing how they should be bred, if necessary. Until the work is on a thorough, well-organized basis, the approval of mares should be done by the men in charge of districts or their expert assistants.

The men in charge of stallions as stud grooms should be employees of the Department of Agriculture, for whose appointment experience in the handling of horses should be the first consideration. Preference should be given men who had been honorably discharged from the mounted service of the Army and who presented certificates from officers in whose commands they had served showing their proficiency in horsemanship.

It is hardly necessary to point out the desirability of having the breeding service so organized that it will be carried on from year to year by the same or about the same corps of employees, in order that it may have a definite, stable, and continuous policy.

THE PURCHASE OF STALLIONS.

Stallions should be purchased by a board of three, composed of an officer of the Army, an officer of the Department of Agriculture, and a practical horseman, whose knowledge of breeds, pedigree, and markets, and whose integrity can be relied upon.

In selecting the stallions, suitability for the purpose and freedom from unsoundnesses likely to appear in progeny should, of course, be first considered, and the stallions should be old enough to have shown their worth as sires of the class of horses desired. In buying Standardbreds, Saddlers, and Morgans, any tendency to pace, rack, mix gaits, paddle in front, or sprawl behind should disqualify, and only those stallions should be selected which come from families which show none of these tendencies to a marked degree. The presence of such faults in their get would, of course, disqualify them.

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EXPENSE.

It is believed that this plan could be put into full operation at a cost not to exceed $250,000 for the first year. This will allow for the purchase of first-class stallions with proved stud records and will provide for the employment of first-class men to carry on the work. The expense in subsequent years, on the same basis of 100 stallions, would require appropriations estimated at $100,000 annually, which would allow for the replacing of stallions as necessity required.

On the basis of 40 mares per stallion the system would cost about $40 per colt produced. If the maximum of 70 mares were covered by each stallion, the cost per colt produced would be about $20. Considering the fact that the normal stud fee in the country is from $10 to $25, with a probable average of $15, it will be seen that under this system the expense would be somewhat greater than by using privately owned stallions, but it is believed that the advantages of breeding and the results in foals would more than compensate for the increase. While the increased cost would not necessarily be made up to the Central Government, the increase in State and local taxes on more valuable foals would more than counterbalance the loss under this system. As a matter of fact the resultant cost of such a careful system of breeding can not be computed in dollars and cents, particularly as the effect of systematic effort in the breeding of Army remounts should have such a favorable influence on all breeding in this country as to be of inestimable benefit to the horse industry and far outweigh any expense that might be debited against this system.

THE DAIRY DIVISION.

The Dairy Division, of which Mr. B. H. Rawl is chief, covers in a broad way work relating to the dairy industry. This work is organized in five branches, as follows: Dairy farming investigations, dairy manufacturing investigations, market milk investigations, research laboratories, and renovated butter inspection.

A valuable part of the work of the Dairy Division is the diffusion of helpful information among those engaged in the various branches of the dairy industry. An important means of furthering this object is by attending meetings and giving lectures and addresses. During the fiscal year the Dairy Division was represented at 327 gatherings, ranging from small local meetings of farmers to large conventions, and including meetings of live-stock and cow-testing associations, conferences of milk producers, dealers, consumers, and health officials, and meetings of medical societies, besides the giving of lectures at dairy schools, attendance at fairs and milk exhibits, and the trip of a special dairy train.

The farm at Beltsville, Md., recently acquired by the bureau, when fully equipped will afford facilities that have long been needed by

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the Dairy Division for carrying out more satisfactorily investigations already under way and for investigating other problems that should be studied under actual farm conditions. The various workers of the division will thus be kept in closer touch with farm practice, and will thereby be better qualified for the work they have in hand. For lack of proper facilities much of the experimental work has hitherto been carried on in cooperation with State experiment stations, but it is expected that such cooperative work will not be found necessary or advisable to the same extent in the future.

With educational work the case is entirely different. It would seem that the ideal system of conducting such work in dairying would be to have it done by the States and not by the Dairy Division; but since many States are doing nothing in this direction, and others are doing but little, the division should use its efforts in helping the States to get the work started. Our experience convinces us that this is the only way that we should take up educational work, and this is the idea with which all such work now being done by the division has been undertaken and is being carried on.

DAIRY FARMING INVESTIGATIONS.

The work relating to dairy farming investigations is in charge of Mr. Helmer Rabild.

HERD RECORDS.

The low average production of the dairy cows of the United States is a condition that does more than any other one thing to prevent development. The dairyman whose herd is averaging 400 pounds of butterfat is not the man who opposes the tuberculin test or who has unimproved equipment and filthy surroundings. On the contrary, he seeks the tuberculin test, and seeks information of all kinds that will enable him to protect his herd and his business and to conduct his business in the best possible manner. The man who is fighting the tuberculin test, milk ordinances, and the inspectors, and who is continually making the greatest complaints about unremunerative prices, is usually the owner of the average cow, which produces not over 150 to 175 pounds of butterfat per annum.

Work that tends toward the improvement of the latter type of dairyman, therefore, has a direct effect upon most of the vital problems confronting the dairy industry. At present he recognizes that he derives but little profit from his business, and he naturally concludes that sanitary requirements, the tuberculin test, etc., are going to reduce his profits further, which his business can not stand. But when the productiveness of his cows has been improved and they have become profitable, he is naturally inclined, for the sake of his own business interests, to house and care for them better and to protect them from tuberculosis and other diseases. In so doing he com-

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plies with a large part of the health requirements. With herd records kept but one day in a month the best cows can soon be identified; and if a purebred bull of good quality is used, only a few years are required to develop a productive herd and bring about the conditions just indicated.

The main object, therefore, of the field work that is now in progress in the South and West, and of the cow-testing association work in the North, is to establish the use of the herd record and the purebred sire. In order to further this work in every possible way all reliable records from these various sources are collected in Washington, compiled, and interpreted, so that the results may be of most use in educating the dairyman.

SOUTHERN FIELD WORK.

The southern field work for the development and improvement of the dairy industry, which has been continued along the same general lines as reported in previous years, is now in progress in nine States, namely: Alabama, Georgia, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Texas, and Virginia. Usually but one man works in a State and he devotes his time largely to individual dairymen located in different sections, the object being to assist one dairyman in a locality to operate his dairy in a thoroughly profitable manner, thereby providing an object lesson for the benefit of the locality. On the whole this work has been very successful. It has not only done much in the way of demonstrating the possibilities of dairying in the South, but it has also demonstrated a most practicable system of developing the dairy industry to take advantage of those possibilities.

In all the States this work has received increased attention from the State institutions, and it is fully expected that in time these institutions will take over the work entirely. North Carolina is providing funds rather liberally for the maintenance of the work, and it is probable that the department's assistance will cease to be necessary in that State and perhaps in other States during the coming year. It is the purpose to withdraw such assistance just as rapidly as possible and transfer it to other States in the South and West.

The following are some of the particular lines of work in progress: Herd improvement and economical feeding; furnishing plans for dairy barns, silos, dairy houses, etc., and giving advice in their erection; assisting in the organization of dairy and live-stock associations; improving city milk supplies; assisting in short courses of dairy instruction and in meetings and fairs; oversight of creamery organization.

During the year records of 57 herds containing 964 cows were kept by dairymen in the South under the supervision of the Dairy Division, and in addition a number of dairymen—in one State as many

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as 35—have been conducting herd records without the assistance of the field men. One man keeping records under the instruction of the field agent reduced the cost of milk production from $1.34 to 69 cents per 100 pounds, a saving of nearly one-half.

The use of the purebred bull comes as an immediate result of the herd records, and field workers during the past year have been able to induce about 20 dairymen to buy purebred bulls. They have also assisted farmers in the purchase of good dairy stock to replace the unprofitable cows of their herds.

Fifty silos have been built in the Southern States during the past year as a result of the work of the Dairy Division. On account of the permanency of concrete construction that type of silo is now being built whenever possible. Reports on 20 concrete silos built during the past two years show that the average cost per ton capacity was $2.35, while the average cost of 57 stave silos was $1.50 per ton capacity. One dairyman reports that in two seasons his silo has saved him at least $2,000 above its cost. A circular giving directions for building concrete silos has been prepared for publication.

Twenty-nine new barns and 10 new dairy houses were built during the past year, and 12 old barns were remodeled.

Assistance has been given in improving the milk supplies of 20 cities, the score-card system of inspection being used.

Assistance has been given in organizing creameries in North Carolina, Tennessee, and Mississippi. Creamery promoters are constantly making an effort to sell creamery plants throughout this section. There are but few localities where dairying is sufficiently developed to make it possible to operate a creamery with success, hence the Dairy Division tries to discourage such enterprises where local conditions are such that they can not succeed. Wherever the conditions are reasonably favorable all possible assistance is given in organizing creameries and getting the work properly started.

Assistance was given by the field men at 13 fairs. At each of these a butter contest was held. A small exhibit of plans of dairy buildings was made, and publications on various dairy subjects were distributed. At a number of the fairs working dairies were conducted by the field men. A 12 months' butter contest was conducted in North Carolina. Thirty dairymen entered, and 19 remained to the close. A milk, cream, and butter contest was conducted with great success in connection with the South Carolina Dairy and Live Stock Association. One hundred and six agricultural meetings were attended by the field workers, and seven short courses of dairy instruction of from three to six days were given.

During the year three new dairy and live-stock associations were organized, and meetings were held with the six associations organized the previous year.

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WESTERN FIELD WORK.

During the last few months of the fiscal year work similar to that being done in the South was begun in Colorado and Idaho. The Western States offer splendid opportunities for dairy development, and it is desirable to increase the work in that section just as rapidly as funds will permit. The number of small farmers in that section is rapidly increasing, and raising beef cattle on such farms is often unprofitable; many of the farmers therefore very readily take up dairying.

WORK WITH CREAMERY PATRONS.

Extensive as have been the investigations relating to butter manufacturing, the general quality of butter seems to continue to become lower. The competition in cream buying is often very strong, so that if one buyer refuses to take cream because it is in bad condition another buyer stands ready to take it in spite of its condition. Thus the quality of cream sold to creameries has been getting poorer and poorer. Investigations in the creamery alone are ineffective in overcoming this difficulty, and the work must be carried to the farmer. One experiment has been begun among the patrons of a creamery in Iowa whereby each patron's cream will be graded for quality, and those that are making good cream will be shown that they are receiving from 1 to 3 cents a pound less because it is mixed with the poor cream from the other patrons, while those who are producing poor cream will be offered assistance in improving the quality, and finally an effort will be made to have the cream paid for by grade. It is believed that the increased value of the better product will more than cover the cost of the improvement.

COW-TESTING ASSOCIATIONS.

The purpose of cow-testing associations has been explained in previous reports, and this work has been made the subject of a paper in the Twenty-sixth Annual Report of the bureau. Two men are now employed in giving assistance to State officials in organizing and conducting cow-testing associations. No assistance is given by the Dairy Division unless some State or local institution takes immediate control. During the past year 28 new associations have been organized, making a total of 55 in the United States at the present time. These associations are located as follows: Wisconsin, 12; Vermont, 9; Maine, 6; Michigan, 6; Iowa, 5; California, 3; Ohio, 3; Pennsylvania, 2; Colorado, Connecticut, Illinois, Maryland, Nebraska, New Hampshire, New York, Oregon, and Washington, 1 each.

A number of dairymen, after the first year's test has been completed, think that they have gained all the benefits to be derived from cow testing and do not wish to continue the work. It is then neces-

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sary to convince them that by continued testing the production of the herd may be further increased. An example of the advantages derived from continued testing is shown by the records of the Newaygo County Dairy Testing Association in Michigan, which has completed four years' work. The following table gives the yearly average per cow of 9 herds which have been in that association since the beginning:

Results of continued testing in a Michigan cow-testing association.

Year.	Number of cows.	Milk produced.	Butter-fat produced.	Value of butter-fat.	Cost of feed.	Profit.	Returns for $1 expended in feed.
		Pounds.	*Pounds.*				
1906	70	5,802	232.7	$54.66	$33.23	$21.43	$1.64
1907	85	5,987	241.4	71.02	39.29	31.73	1.81
1908	86	6,011	258.2	70.70	40.61	30.09	1.74
1909	89	6,426	277.6	86.52	43.70	42.82	1.98

This table shows an increase in the average production per cow, while the average profit has been practically doubled.

SILO AND VENTILATION EXPERIMENTS.

An experiment to determine the strength that a building must possess in order to withstand pressure of silage was reported last year. It is now in progress for the second year. This year's work may give sufficient data to warrant conclusions; if not, it will be necessary to continue the experiment for another year.

An experiment in stable ventilation was reported last year as having been in progress for two years, and the work is not yet complete. This experiment was not continued during the past winter owing to the lack of proper facilities, but will be resumed on the newly acquired farm of the bureau as soon as sufficient equipment is available.

DAIRY MANUFACTURING INVESTIGATIONS.

Mr. B. D. White is in charge of the section dealing with dairy manufacturing investigations.

MARKET INSPECTION OF BUTTER.

Market inspection of butter has been conducted at the New York, Chicago, and San Francisco markets. This inspection is made at the request of the dealer or the producer, and the defects of the butter are pointed out and suggestions given for overcoming them. During the fiscal year there were 3,058 inspections made, of which 1,500 were made in New York, 1,478 in Chicago, and 80 in San Francisco. Be-

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sides inspections for quality, the inspectors have made tests for salt and moisture, and have weighed shipments of butter to determine the shrinkage between the creamery and the market. In replies from 252 creameries to an inquiry from the bureau, 184 stated that the work had proved beneficial, 59 had no opinion, and 9 knew of no beneficial results. The dealers in butter also expressed much appreciation of the inspectors' work.

CREAMERY INVESTIGATIONS.

During the year 157 new creameries have been reported. Plans for organization, articles of incorporation and by-laws, lists of machinery, and plans for creamery buildings have been furnished to these new creameries by the Dairy Division when they could be used to advantage. Besides assisting in the organization of creameries under favorable conditions, the establishment of creameries has been discouraged in localities where there was an insufficient number of cows to keep a creamery running successfully.

Investigations and advice in the management of creameries have been continued during the past year very much as heretofore. Five men have been giving the greater part of their time to this work. They have been cooperating with State departments and dairy schools in teaching creamery operators better methods. Much money is lost to creameries annually by the lack of proper business methods. The large creamery usually checks up every operation; the small creamery usually checks up none. It has been estimated that the loss from bad management in three of the leading butter manufacturing States has been reduced more than $400,000 annually within the past three years, but that those same States still sustain a loss from this source of more than $1,200,000 every year. This statement shows the benefit as well as the need of work such as the Dairy Division is doing.

Many creameries have no method of disposing of their sewage. Plans for septic tanks were sent to 39 creameries during the year. Some further study of this subject is necessary, however, to perfect the septic tank for creamery purposes, owing to the amount of grease contained in the sewage.

Nearly every creamery has some patrons who take pride in furnishing clean, sweet cream, from which the highest grade of butter can be made. At the same time there are usually many patrons who have no special interest or pride in the quality of cream they send to the creamery so long as it is accepted; and the result is that much of the cream brought in is sour, tainted, or dirty, and unfit for making butter of fine quality. There are some patrons who are absolutely filthy in their practices in handling their product, and their cream is often utterly unfit for use in making a food product. The present system of paying one price for all cream is therefore unfair and

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should be abandoned. A few creameries have adopted a system whereby two grades are maintained. The first-grade cream must be clean, sweet, and fresh, and a premium of from 1 to 3 cents a pound of butterfat is paid for it. This cream is churned separately, and the butter from it sells at from 1 to 4 cents a pound premium. The second-grade cream is sour, but must be clean; and for it the quotation price is paid. Under this system any cream below second grade is refused. By means of grading those patrons who are interested enough to produce clean, sweet cream get a premium which is worth the effort, while the creamery gets a premium which makes the method profitable to it also. Wherever grading has been adopted it has resulted in better prices to patrons and better product from the creamery.

There is a promising field for development in the manufacture of by-products by creameries or engaging in incidental enterprises that may well be carried on in connection with the regular work and that will avoid waste and enhance the profits; for example, manufacturing ice cream, casein, or some varieties of cheese; feeding hogs, selling sweet cream, handling eggs, manufacturing ice and condensed milk, and furnishing cold-storage space. Some creameries are already doing these things, but most of them are not, and little has been done to introduce and develop such lines of work A tremendous amount of nutritious food is now wasted or unprofitably used by the creameries. The Dairy Division is now giving some attention to this subject of by-products and side lines and hopes to be able to assist the creameries in taking up such enterprises.

INSPECTION OF BUTTER FOR THE NAVY.

The Dairy Division inspected during the fiscal year 768,177 pounds of butter packed on contract for the United States Navy. This butter was packed between April and August, 1909, and placed in storage. It was inspected as packed, and a sample from each churning was held until February or March, 1910, and then examined as to its condition and keeping qualities. In general this butter was found very good. It was better after eight months of storage than perhaps three-fourths of the entire amount of butter arriving on the general market. Many samples were found to be as good as when packed. Some valuable information was gained in regard to manufacturing and packing methods, and it was found that butter made according to methods recommended by the Dairy Division did not develop the fishy flavor which often injures the quality of stored butter. It is estimated that this inspection caused a saving to the Navy Department of over $50,000 in the expense for butter, and that department has requested that the Dairy Division continue to oversee the packing of the butter for the Navy.

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MARKET MILK INVESTIGATIONS.

The work of the section of market milk investigations, of which Mr. George M. Whitaker is in charge, deals mainly with the improvement of milk supplies, and is done very largely in cooperation with public health officials. In connection with this work during the past fiscal year over 150 visits were paid to various towns and cities to consult with and assist citizens and officials for the advancement of market milk conditions, and agents of the Dairy Division inspected 332 dairies and milk plants, judged in 9 milk contests, assisted in 6 dairy exhibitions, and attended and addressed 83 public meetings.

The score-card system of inspection, under which dairy farms and milk depots are inspected and rated for specific items on a scale of 100 points, is largely used in this work. One hundred and seventeen municipalities are using the score card in official inspections, in 14 States it has been adopted to a varying extent, 11 milk dealers use it in inspecting the dairies from which their supply is obtained, and 18 agricultural colleges use it in the class room. The system is in use in 8 of the 15 largest cities in the country.

The improvement brought about in the wholesomeness of the milk supply by means of this work is well illustrated by the following table, showing results in six cities selected from different sections of the country and representing places of a wide range of population, as reported by the local officials who made the scores:

Improvement in milk supplies of six cities as shown by score cards.

Cities.	Average score in 1909.	Average score in 1910.	Average points gained.	Percentage of gain.
Los Angeles, Cal	55	63	8	15
Glens Falls, N. Y	49	62	13	27
Concord, N. H	40	46	6	15
Hudson, N. Y	40	50	10	25
Clinton, Iowa	56	67	11	20
Portland, Oreg	35	45	10	28

This is an average gain of 22 per cent for the places named. The gain is always most rapid and most noticeable when the work is new, as in the above places, and when very poor conditions are being improved, though further improvement follows the continued use of the system.

The Dairy Division encourages efforts to improve the milk supply, even though the score-card method is not adopted. During the year assistance was given to 101 municipalities under these circumstances.

A month was spent by one man in an investigation of the farms which produce milk for Chicago. Dairies in all parts of the Chicago

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territory were inspected, and it was found that 46.7 per cent of those inspected were rated below 40, 43 per cent between 40 and 50, and only 10.3 per cent above 50. It is considered that any dairy scored below 50 should not be allowed to place milk on the market; hence it will be seen that there is much room for improvement in the Chicago territory. Fortunately, however, there is abundant evidence of improvement taking place, showing that the health department has started a movement which will eventually do much to raise the quality of the Chicago milk supply.

At the request of the Bureau of Chemistry in connection with its work of administering the food and drugs act, the Dairy Division has inspected and scored dairies producing milk for interstate shipment and whose product did not conform to the law.

A draft of a milk law recommended as applicable to most regions has been sent on request to many persons interested in procuring such legislation.

A paper on "The care of milk in the home" was prepared during the fiscal year and has been published in a Farmers' Bulletin.

The Dairy Division has also assisted the movement for better milk by lending for various exhibitions large photographs showing good and bad dairy conditions.

RESEARCH LABORATORIES.

The research laboratories, in charge of Mr. L. A. Rogers, are devoted to experimental work, largely of a bacteriological and chemical character, with special reference to the study of processes employed and problems arising in the manufacture of dairy products. Besides the main laboratory in Washington there is a branch laboratory at Albert Lea, Minn., devoted to butter and Swiss cheese investigations. In addition, cooperative investigations with State experiment stations are being carried on at Storrs, Conn.; Madison, Wis.; and Columbia, Mo.

BUTTER INVESTIGATIONS.

Various problems relating to butter are being studied. More recent work has confirmed the results of earlier experiments in showing the superiority of butter made from sweet cream for storing purposes, and particularly when stored at a comparatively high temperature. In continuing this work, butter for storage is being made in three ways—from pasteurized sweet cream, from pasteurized ripened cream, and from ripened raw cream. Portions of each lot are stored at zero, 10° F., and 20° F. The butter is scored when put in storage and again when taken out six months later.

Experiments have been made to determine the proper temperature for pasteurizing cream for butter making. Various temperatures

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from 140° to 200° F. were used. Results show that an efficient temperature from a bacteriological standpoint varies with the condition of the cream, but that 160° F. seems to give the best results. The scores of butter made from cream pasteurized at from 160° to 180° F. seem comparatively uniform, but are variable below that range, and the butter has a scorched flavor above it.

The relative cost of making butter from pasteurized and unpasteurized cream is being investigated. For a period of one week all the cream is pasteurized before it is churned. The next week it is churned raw. For 19 periods this work has been in progress, and it will be continued.

Much of the cream used in some creameries is very sour when it reaches the creamery, and in order to get rid of the excess of acid it is neutralized with lime. The detection of such butter is desirable, but no reliable method has heretofore been available, and experiments are being conducted by the Dairy Division with a view to arriving at such a method. The experiments so far show that such butter contains an excess of calcium, although butter in which a large amount of inferior salt is used shows a similar excess of calcium. However, the magnesium content of butter is increased by the use of lime, and not by the use of salt. It is hoped, therefore, to establish a ratio of magnesium to calcium for normal butter, and thereby make possible the identification of butter from neutralized cream.

A common defect in butter is a peculiar flavor known to butter judges as "metallic flavor," which is supposed to be the product of such metals as iron and copper. Investigations regarding this matter are now under way.

An experiment is being made whereby it is sought to volatilize and condense a sufficient quantity of the flavoring matter in butter so that it may be identified. If this can be done it will help to determine the changes that take place in butter and the factors causing them. Most of this work so far has been on apparatus and methods.

A large number of cultures of lactic-acid-forming bacteria have been collected from various sources, and a study has been made of their cultural characteristics and their ability to ferment different compounds. It was found that while no distinct differentiation could be obtained by means of ordinary cultural characteristics, the fermentation of various test substances could be so coordinated that the group could be separated into several distinct varieties. While the work will be continued, a part of it is now ready for publication.

A very large amount of the farm butter now made is very inferior and sells for a greatly reduced price. Studies are being made by which it is sought to determine the causes of the serious defects in farm butter. The work done so far has been largely of a preliminary character. Samples of butter made in various sections of the country

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have been examined, and the methods used on a few of the best farms in Vermont are now being studied.

In maintaining an efficient inspection of the renovated butter factories and their products, more information relative to renovated butter, the packing stock used in making it, etc., is badly needed. A laboratory is therefore being equipped in which a miniature renovating plant will be installed and the various problems taken up. Only preliminary work has been done so far.

Neutral lard is doubtless used to adulterate butter, particularly renovated butter. So far no reliable method is available for determining its presence in butter unless it is there in large quantities. A study of this problem is now under way, but the work has not progressed far enough to warrant positive conclusions.

MILK INVESTIGATIONS.

An extensive study has been made of the bacteriology of commercially pasteurized and raw market milk, the milk used being purchased in Washington, New York, and Boston. All of the commercially pasteurized milk soured normally, due in part at least to the wide distribution of a strain of lactic-acid bacteria possessing exceptional resistance to heat. All changes due to bacteria are delayed in pasteurized milk for a period depending on the original bacterial content of the milk, the efficiency of the pasteurization, and the handling of the milk after pasteurization. There was observed no development of bacteria in the pasteurized milk that could be said to make it more unsafe than raw milk kept under similar conditions. This work has been completed, and a full report of it is now in the hands of the printer.

An exhaustive investigation is now under way for the purpose of determining the number and variety of bacteria that survive pasteurization under controlled conditions.

The alkali-forming bacteria which cause the decomposition of milk play a very important part in market milk, and particularly in clean raw milk and pasteurized milk. Dirty milk sours quickly, and hence is discarded by the ordinary consumer before the alkali formers have had time to develop and decompose it, but such is often not the case with clean milk. A knowledge of the thermal death point of this class of bacteria is therefore very important, and a study of this subject is being made.

For several years the Dairy Division has been cooperating with the Missouri Experiment Station in conducting experiments pertaining to milk secretion. The main problem under investigation is the effect of feed on the composition and properties of milk. Before it was possible to study this problem, however, it was necessary to investigate many minor problems that had an important bearing on

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the main problem, such as, for example, the normal variation in milk from milking to milking, the variation occurring during the advance of the lactation period, the variation due to the cows gaining or losing in body weight, the variation due to different breeds, etc. Some of these experiments have been completed and the results published; others are almost completed. The work in progress or recently completed is as follows:

1. The effect upon the milk of gaining or losing body weight. The cows are fed so that they will gain or lose in weight, and the composition of the milk is studied.

2. The effect of cotton seed, cottonseed meal, and cottonseed hulls on the composition and properties of the milk. This investigation is not complete, but so far there is less effect from such feeds than is usually attributed to them.

3. The changes in milk from milking to milking. Comparisons are made between earlier and later portions of the same milking; also between milk drawn twice, three times, and four times a day. The data are practically complete.

4. The composition of human milk and changes during lactation period, as compared with cow's milk. The investigations are completed, but not ready for publication.

5. Some progress has been made in isolating and identifying the coloring matter of butterfat.

6. A method and an apparatus have been devised for measuring the hardness of butterfat and other fats. The methods previously in use were crude. The new method promises decided improvement.

CHEESE INVESTIGATIONS.

Swiss cheese.—The investigations at Albert Lea, Minn., relative to various problems involved in the manufacture of the Swiss type of cheese, have been continued. Most of this work has been preliminary in character. The use of "starters" has resulted in some improvement of the texture and possibly a suppression of gas formers. On a commercial scale conflicting results have been obtained.

Cheddar cheese.—Experiments in coating cheese with paraffin to improve its keeping qualities have been made to determine the temperature at which paraffin should be applied, the length of the application, and the age of the cheese at which it is best to apply the paraffin. The best results were secured with paraffin at a temperature of 240° F. when the cheese was 3 days old.

Some preliminary work has been done on the feasibility of canning cheese of the Cheddar type directly from the press. Cheese put up in this way ripens normally, but has a softer texture than ordinary cheese. This work will be continued by comparing canned cheese with cheese made from the same vat and ripened in the ordinary way.

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A study is being made at Madison, Wis., in cooperation with the Wisconsin Experiment Station, of such problems as the influence of various factors, such as acidity of milk, proportion of rennet used, size of curd cubes, time, temperature, pressure, etc., on the moisture content of cheese. The results thus far obtained have been published in Bulletin 122.

As a result of the investigations in making cheese from pasteurized milk the method has been so perfected that it is possible to bring factory milk into practically uniform condition every day, so that a definite routine method of manufacture may be followed throughout the year. From February to July between 150 and 300 pounds of cheese were made daily by this process. The cheese has been very uniform in quality, has had a clean, mild flavor, free from taints, and an almost perfect texture. This cheese has been sold at the highest market price. On account of its good texture and the tendency to hold its shape, a large part of this cheese has been shipped to the Southern States, and the reports indicate that it is superior for this purpose to the ordinary cheese.

An extended study has been made of the volatile fatty acids and esters formed in the ripening of normal cheese and in cheese made from pasteurized milk and their relation to the development of flavor. These products have been found absent in cheese treated with chloroform, indicating that their origin is due to a biological factor or enzymatic agent produced by lactic-acid organisms.

Soft cheese.—Several European varieties of soft cheese are of great commercial importance in the United States, and for a number of years the Dairy Division has been investigating them in cooperation with the Storrs (Conn.) Agricultural Experiment Station with a view to their production in this country.

Most of the problems connected with the production of the Camembert type of cheese in the United States have been fully covered, and the results obtained have been published in several bulletins of this bureau. During the early part of the year the enzym experiments were continued, particular attention being given to the enzym that was found to be directly concerned in the ripening of this cheese. It is necessary to resume some portions of this work at a later time. It is also contemplated to continue experiments in order to study three points not fully covered in previous reports, namely, the effect of relative humidity of the air in the ripening room upon the water content in cheese containing various initial percentages of water, the effects of increasing the percentage of salt in Camembert cheese as suggested by recent studies of Roquefort, and the desirability of lowering the curdling temperature 2° to 3°, as has been found effective in Roquefort.

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The staff at Storrs has devoted the greater portion of the past year to the study of the Roquefort type of cheese. In regard to the practical part of the work, two cheeses of this type are made each day, and a cheese maker is fully occupied in keeping the necessary records and in caring for the cheese in the ripening cellar. The ripening period averages between three and four months. Regarding the chemical work, one of the first problems was to determine the proportions of the various constituents, so as to ascertain, if possible, the distinguishing features between this and other varieties of cheese. The high percentage of salt was found to be of great importance. An analysis of all the brands of imported Roquefort cheese brought out the fact that the salt content of this type of cheese is quite uniformly about 4 per cent. Very few other kinds of cheese show even half of this percentage. The consistently high quality found in imported Roquefort cheese made a special study of this point necessary. The effect of salt in cheese was studied in addition, from a bacteriological point of view, and also with regard to the molds. A preliminary report covering the problems considered and the progress made in this branch of the work is in course of preparation.

Mycological work.—Molds are of considerable economic importance not only in cheese making but in many other branches of agriculture. Studies have been continued upon species of *Aspergillus* and *Penicillium*. These two genera include a large majority of the molds which are found in studying dairy, food, and household problems. Several experiment stations are studying the toxic effects of feeding moldy grain to domestic animals, and many of the organisms discovered in such work are sent to the laboratory at Storrs for identification and verification. This work is being organized and continued in such manner as to be of permanent value.

RENOVATED BUTTER INSPECTION.

The inspection of renovated or "process" butter and of the factories where it is produced is carried on under the act of Congress of May 9, 1902, and is in charge of Mr. Robert McAdam. The Dairy Division is assisted in this work by some of the members of the meat-inspection force of the Inspection Division, as it is found that the same men can often attend to both classes of inspection in the same localities. In this work the bureau also cooperates with the revenue officers of the Treasury Department, especially by making moisture tests and notifying those officials when butter is found containing moisture in excess of the legal limit of 16 per cent.

During the past fiscal year 42 factories were bonded for the purpose of manufacturing renovated butter, although several of these did not operate throughout the entire year. These factories produced during

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the year 46,914,494 pounds of renovated butter, a decrease of 517,782 pounds from the preceding year. There was a heavy decrease of exports of this butter, the exports being only 41,850 pounds, as compared with 1,115,288 pounds exported during the previous year.

DAIRY ARCHITECTURE AND ENGINEERING.

For the past few years the Dairy Division has prepared plans for dairy buildings and distributed blue prints to a limited extent. This has been continued during the past year, and it has also been found desirable to take up some of the engineering and mechanical problems connected with the dairy industry, such as the equipment of buildings, refrigeration, sewerage systems, and apparatus of various kinds. Some of this work is necessary to investigations carried on by the Dairy Division, aside from its advantage to the industry. In connection with creameries and milk production there is need for much work on ice houses and refrigerating machinery. Storing ice is a practice that should be encouraged among dairy farmers. It is hoped that the facilities for work of this kind may be enlarged.

THE INSPECTION DIVISION.

The work of the Inspection Division, under the direction of Dr. R. P. Steddom, chief, consists of the meat inspection and the control and eradication of contagious diseases of animals.

THE MEAT INSPECTION.

The meat inspection was conducted during the past fiscal year at 919 establishments, located in 237 cities and towns, as compared with 876 establishments in 240 cities and towns the previous year. Inspection was inaugurated at 105 establishments and was withdrawn from 91 establishments during the year, as compared with 180 establishments and 77 establishments, respectively, during the previous year. In 70 cases the cause of withdrawal was that the establishments discontinued slaughtering or interstate business, and in 14 cases withdrawal was due to insanitary conditions or to failure or inability to meet the department's requirements as to sanitation or other matters.

The following statement shows the number of establishments and the number of cities and towns where the inspection of meat and meat food products was conducted by the bureau in each fiscal year, beginning with 1891.

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Number of establishments and number of cities and towns where meat inspection has been conducted, fiscal years 1891 to 1910.

Year.	Establishments.	Cities and towns.	Year.	Establishments.	Cities and towns.
1891	9	6	1901	157	52
1892	23	12	1902	155	50
1893	37	16	1903	156	50
1894	46	17	1904	152	51
1895	55	19	1905	151	52
1896	102	26	1906	163	58
1897	128	33	1907	708	186
1898	135	35	1908	787	211
1899	139	42	1909	876	240
1900	149	46	1910	919	237

During the fiscal year market inspection was extended to two more cities, making a total of 39 cities at whose public markets Federal meat inspection is conducted in order that interstate deliveries may be made without violating the meat-inspection law and regulations.

ANTE-MORTEM INSPECTIONS.

The number of animals of each species inspected before slaughter is shown in the following statement, which, though showing a material increase in the number of cattle, calves, sheep, and goats inspected, shows so large a decrease in the number of swine as to make the total ante-mortem inspections over 7,000,000 less than in the previous year:

Ante-mortem inspections of animals, fiscal year 1910.

Kind of animals.	Passed.	Suspected.[1]	Total.
Cattle	7,956,427	43,120	7,999,547
Calves	2,293,216	2,584	2,295,800
Sheep	11,155,646	8,989	11,164,635
Goats	116,035	28	116,063
Swine	27,717,164	14,463	27,731,627
Total	49,238,488	69,184	49,307,672

[1] This term is used to designate animals found diseased or suspected of being unfit for food on ante-mortem inspection, most of which are afterwards slaughtered under special supervision, the final disposition being determined on post-mortem inspection.

POST-MORTEM INSPECTIONS.

The inspections made at the time of slaughter are shown in the following statement, which, while showing an increase in the slaughter of all classes of animals except swine, shows a decrease of nearly 6,500,000 animals as compared with the preceding year:

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Post-mortem inspections, fiscal year 1910.

Kind of animals.	Passed for food.	Passed for lard and tallow only.	Condemned.	Total.
Cattle	7,916,601	3,162	42,426	7,962,189
Calves	2,287,568	7	7,524	2,295,099
Sheep	11,138,781	29	11,127	11,149,937
Goats	115,585	....	226	115,811
Swine	27,532,600	70,982	52,439	27,656,021
Total	48,991,135	74,180	113,742	49,179,057

In the foregoing table are included the post-mortem inspections of the carcasses of animals "suspected" on ante-mortem inspection, the final inspections of carcasses that were retained[1] at the time of slaughter, and the carcasses of animals slaughtered without ante-mortem inspection and presented at inspected establishments with the head and viscera attached as required by Regulation 20 of the meat-inspection regulations.

The various diseases and conditions for which fresh carcasses and parts were condemned and tanked are shown in the following table:

Diseases and conditions for which condemnations were made on post-mortem inspection, fiscal year 1910.

Cause of condemnation.	Cattle.		Calves.		Swine.		Sheep.		Goats.	
	Carcasses.	Parts.	Carcasses.	Parts.	Carcasses.	Parts.	Carcasses.	Parts.	Carcasses.	Parts.
Tuberculosis	27,638	48,997	184	166	28,882	720,775	......	......	......	......
Actinomycosis	527	53,008	1	85	......	......	......	......	......	......
Caseous lymphadenitis	......	......	......	......	......	......	1,122	......	25	......
Hog cholera	......	......	......	......	7,677	......	......	......	......	......
Tumors and abscesses	171	7,070	35	61	932	1,516	164	41	3	......
Septicemia, pyemia, and uremia	1,027	......	309	......	5,561	......	539	......	11	......
Pregnancy and recent parturition	209	......	......	......	40	......	72	......	......	......
Immaturity	......	......	3,472	......	......	......	......	......	......	......
Pneumonia, pleurisy, enteritis, hepatitis, nephritis, metritis, etc	1,872	......	346	......	4,502	......	1,572	......	54	......
Icterus	74	......	43	......	1,248	......	909	......	13	......
Texas fever	435	......	657	......	......	......	......	......	......	......
Injuries, bruises, etc	3,333	5,253	499	166	383	2,915	657	183	11	1
Sexual odor	......	......	......	......	786	......	......	......	......	......
Asphyxiation	......	......	......	......	630	......	42	......	......	......
Emaciation	6,476	......	1,762	......	932	......	5,376	......	81	......
Miscellaneous	664	7,839	216	22	866	1,623	674	24,490	28	......
Total	42,426	122,167	7,524	500	52,439	726,829	11,127	24,714	226	1

[1] This term is applied to carcasses held on suspicion on first post-mortem examination to be subjected later to more thorough examination for determining final disposition.

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SUPERVISION OF PREPARATION OF MEATS AND PRODUCTS.

The amount of meats and meat food products prepared and processed under the supervision of the bureau is shown in the following statement, being a decrease of 8.5 per cent from the preceding year:

Meat and meat food products prepared and processed under bureau supervision, fiscal year 1910.

Kind of product.	Weight.	Kind of product.	Weight.
	Pounds.		*Pounds.*
Beef placed in cure	205,762,443	Bakers' compound	2,499,309
Pork placed in cure	2,216,680,470	Oleo stock and edible tallow	55,034,672
All other classes placed in cure	2,223,590	Oleo oil	156,374,212
Sausage, chopped	485,863,902	Oleo stearin	83,713,020
Canned beef	107,050,501	Oleomargarin or butterine	139,158,391
Canned pork	17,862,128	Mutton stock	325,604
All other canned meats	2,350,311	Mutton oil	1,016,510
Meat extract	429,861	Mutton stearin	715,291
Steam and kettle rendered lard	865,270,940	Oleo and mutton stock	105,939
Leaf lard	19,899,786	Oleo and mutton oil	1,069,865
Neutral lard	63,297,635	Oleo and mutton stearin	131,410
Lard oil	6,736,004	Miscellaneous products	1,115,676,133
Lard stearin	5,689,868		
Lard compound	11,537,949	Total	6,223,964,593
Lard substitute	657,488,849		

The following amounts of meat and meat food products were condemned on reinspection during the fiscal year because of having become sour, tainted, putrid, unclean, rancid, or otherwise unwholesome: Beef, 9,566,199 pounds; pork, 9,273,124 pounds; mutton, 137,598 pounds; veal, 54,616 pounds; goat meat, 271 pounds; total, 19,031,808 pounds. For the past two years there has been a steady and marked decrease in condemnations for these causes as a result of continued improvement in sanitary conditions and in methods of preparing and handling the products.

INTERCHANGE OF MEATS BETWEEN INSPECTED ESTABLISHMENTS.

Considerable quantities of meats and meat food products that have been inspected and passed are transferred between inspected establishments, this traffic being closely supervised and the meats and products identified by means of marks and seals. During the fiscal year there were transferred in this manner 2,734,019,943 pounds of meats and meat food products, part of which was contained in 16,073 sealed cars and 21,169 sealed wagons.

MEATS AND PRODUCTS CERTIFIED FOR EXPORT.

The amounts of meat and meat food products certified by the bureau for export are shown in the following table, being a decrease of 30.7 per cent as compared with the previous fiscal year:

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Inspection certificates issued for export of meat and meat food products, fiscal year 1910.

Kind.	Number.	Beef.	Mutton.	Pork.	Total.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Regular	42,265	212,408,598	4,680,846	377,380,234	594,469,678
Preservative	29,767	1,947,144		218,945,328	220,892,472
Total	72,032	214,355,742	4,680,846	596,325,562	815,362,150

There were also issued 2,174 "inedible product" certificates, covering exports of 17,676,942 pounds of such inedible products as hoofs, horns, casings, bladders, bungs, etc.

IMPORTED OLEO STEARIN.

During the fiscal year 23,416,479 pounds of compound and 118,300 pounds of oleomargarin were manufactured from imported oleo stearin at five inspected establishments located at three seaport cities (Jersey City, New Orleans, and New York). This imported product is kept under lock and key while in these establishments and no domestic meat food product is permitted to be mixed with it. The finished product is also kept under lock and is properly loaded into vessels and exported without certificates, stamps, or other marks of Federal meat inspection.

EXEMPTION FROM INSPECTION.

The provisions of the meat-inspection law requiring inspection do not apply to animals slaughtered by farmers on the farm nor to retail butchers and dealers. The department requires that such butchers and dealers, in order to ship meats and meat food products in interstate commerce, shall first obtain certificates of exemption, but no such requirement is made of farmers. The number of certificates of exemption outstanding at the close of the fiscal year was 2,428, as against 2,114 at the close of the previous fiscal year, an increase of 314 certificates. During the year it was found necessary to call in and cancel for various causes 428 certificates of exemption. In many of these cases, however, the certificates were reissued later when business was resumed or when insanitary conditions had been corrected.

During the year 118,800 shipments were made under certificates of exemption, covering 19,932,221 pounds of meat and meat-food products. Included in these shipments were 102,409 carcasses, of which about 90 per cent were veal.

INSPECTIONS FOR THE NAVY.

Upon request of the Navy Department occasional inspections of meats and meat food products were made for the Navy during the

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year. These inspections were made at Baltimore, Boston, Brooklyn, Jersey City, Los Angeles, New Orleans, New York, Norfolk, Philadelphia, Providence, San Francisco, Seattle, and Washington. The meats and products inspected aggregated 6,448,072 pounds, of which 234,313 pounds were rejected. Rejections were made on account of the sour, slimy, tainted, or putrid condition of the product, for failure to comply with the specifications regarding weight, and because of the substitution of buck heifer, or cow meat for the meat of wethers and steers as specified.

CONTROL OF CONTAGIOUS DISEASES.

TEXAS FEVER.

The number of cattle shipped during the quarantine season of 1909 to northern markets from the area quarantined on account of Texas or splenetic fever of cattle was 1,394,658, being an increase of 252,854 head, or 22.23 per cent, as compared with the previous year. These were carried in 46,741 cars, 45,757 of which were reported as having been cleaned and disinfected under bureau supervision. The number of inspected or dipped cattle moved interstate from the provisionally quarantined area under 1,859 certificates of inspection issued by bureau inspectors was 143,545.

During the fiscal year 35,081 head of southern cattle were dipped in crude petroleum or otherwise treated under bureau supervision for unrestricted movement, as provided in the regulations.

TICK ERADICATION.

As the result of the work done in cooperation with authorities of various States for the extermination of the ticks which spread the infection of Texas fever of cattle, areas aggregating more than 57,000 square miles, as shown by the following table, were released from quarantine during the fiscal year:

Areas released from cattle quarantine as a result of tick eradication.

State.	Square miles.	State.	Square miles.
California	32,271	Georgia	815
Texas	10,675	South Carolina	2,673
Oklahoma	3,076	Virginia	1,695
Arkansas	3,466		
Mississippi	1,407	Total	57,520
Tennessee	1,442		

In addition to the States represented in the above list, active operations are being carried on in North Carolina, Alabama, and Missouri.

During the year the total number of inspections made by bureau employees was 3,745,548, of which 2,589,082 were reinspections. This is an increase of 14.5 per cent over the inspections of the previous year.

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SCABIES IN SHEEP.

The area quarantined for scabies in sheep was reduced during the fiscal year by releasing from quarantine 390,000 square miles, comprising the State of Washington and portions of Oregon, Nevada, Utah, Arizona, and Colorado, while the State of Kentucky was placed in quarantine.

The number of inspections made by bureau employees during the fiscal year was 52,749,920, a decrease of 11.7 per cent from the previous year. The number of dippings supervised by bureau employees was 12,153,356, a decrease of 22.1 per cent, and the number of cars cleaned and disinfected was 2,577.

SCABIES IN CATTLE.

The area quarantined for scabies in cattle was reduced during the fiscal year by releasing 53,021 square miles, consisting of one county in Montana, two counties in Wyoming, parts of five counties in Colorado, seven counties in Nebraska, nine counties in Kansas, and nine counties and parts of four counties in Texas.

The number of inspections made was 18,190,456, a slight increase over the previous year.

The number of dippings supervised was 1,336,829, a decrease of 14.3 per cent, and 8,723 cars were cleaned and disinfected.

GLANDERS IN HORSES.

There were inspected for glanders at Indian schools and agencies 16,264 horses and mules, of which 22 were found diseased and 479 exposed to the disease. This work was done in cooperation with the Office of Indian Affairs of the Department of the Interior.

SCABIES IN HORSES.

The number of horses and mules inspected for scabies during the year was 11,761 and the number dipped was 1,216.

LIP-AND-LEG ULCERATION IN SHEEP.

For several years there has existed in several of the Western States a contagious disease known as lip-and-leg ulceration (necrobacillosis) among sheep, but during the past year this disease seemed to become more extensive and assumed a very virulent form in the State of Wyoming; and, in order that its spread to other States might be prevented, eight counties in that State were, on August 12, 1909, placed under Federal quarantine. The number of inspections during the year for this disease was 34,549,974. The number of dippings and disinfections reported during the year was 2,765,773, with the result that a recent inspection of sheep on the range shows that the disease is decreasing in virulence and that there has been a large decrease in the number of diseased sheep, as compared with the inspection in the fall of 1909.

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REPORTS OF VIOLATIONS OF LIVE-STOCK TRANSPORTATION LAWS AND REGULATIONS.

During the fiscal year employees of the bureau made about 550 reports of alleged violations of what is known as the 28-hour law and 200 reports of alleged violations of the act of March 3, 1905, and regulations based thereon. The information thus obtained was placed before the Department Solicitor, who presented to the Department of Justice for prosecution such cases as seemed to be supported by sufficient evidence. Many of the cases tried required special investigations and the collection of evidence by employees of the bureau, who cooperated with the United States attorneys in charge of the cases.

THE QUARANTINE DIVISION.

The Quarantine Division, of which Dr. R. W. Hickman is the chief, deals mainly with the inspection and quarantine of imported live stock, the inspection of live stock for export, cooperative investigations with State and municipal authorities concerning bovine tuberculosis, interstate tuberculin testing of cattle, and investigations of animal diseases in Porto Rico and the Hawaiian Islands.

INSPECTION OF VESSELS AND EXPORT ANIMALS.

During the fiscal year 443 inspections of vessels carrying live stock were made before clearance, in order to see that the regulations were complied with as to fittings, equipment, ventilation, feed, water, attendants, etc., and 650 certificates of inspection were issued for American cattle. The following table gives statistics of inspection of live animals for export during the year:

Inspection of American and Canadian animals for export, fiscal year 1910.

Kind of animals.	American.				Canadian.		
	Number of inspections.	Number rejected.	Number tagged.	Number exported.	Number of inspections.	Number rejected.	Number exported.
Cattle	225,089	148	120,699	120,351	60,384	27	60,357
Sheep	2,688			1,828	1,988		1,988
Swine	463			463			
Horses	830			879			
Mules	742			742			
Donkeys	1			1			
Elk	24			24			
Bison	1			1			
Eagles	4			4			
Total	229,842	148	120,699	124,293	62,372	27	62,345

Most of the animals included in the above statement were shipped to Great Britain, namely, of American animals, 119,525 cattle, 848

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sheep, 510 horses, 1 donkey, and 14 mules, and of Canadian animals, 59,914 cattle and 1,342 sheep.

The inspection of vessels carrying export animals and the enforcement of the regulations continue to result in an exceedingly low percentage of losses of animals in transit. Statistics of animals landed at British ports show that only 0.12 per cent of the cattle and 0.80 per cent of the sheep were lost at sea, while no horses or other animals were lost.

During the fiscal year 10,257 horses were inspected by bureau veterinarians for shipment to Canada, 7,866 of which were tested with mallein to determine whether or not they were affected with glanders, and 146 were rejected on account of reacting to the mallein test. There were also inspected for exportation to Canada 1,614 cattle, 21,795 sheep, 64 swine, 249 goats, and 1,038 mules. Of the cattle there were tested with tuberculin 560, of which 21 reacted and were rejected. Of the mules 923 were tested with mallein and 8 were rejected.

For shipment to the Hawaiian Islands there were tested with mallein 65 horses and 613 mules, of which 8 horses and 14 mules reacted to the test; also 179 cattle were tested with tuberculin, 23 of which reacted.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS.

Owing to the existence of communicable diseases of animals among the live stock of various parts of the world, importations from over seas have been restricted to Great Britain, Ireland, and the Channel Islands, and it is required that a permit be procured from the Secretary of Agriculture prior to shipment from countries other than North America for cattle, sheep, and other ruminants, and swine, for their landing subject to inspection, and their detention in quarantine at one of the Federal quarantine stations at the port of entry. Horses are admitted subject to inspection and without quarantine.

The number of animals imported during the fiscal year is shown in detail by the following tables:

Number of imported animals inspected and quarantined, fiscal year 1910.

Ports of entry.	Cattle.	Sheep.	Swine.	Goats.	Other animals.
New York	1,912	140	16	9	133
Boston	226	635	7	3	16
Philadelphia					9
San Francisco					5
Canadian border ports	147	6,522	3		
Total	2,285	7,297	26	12	[illegible]

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Number of imported animals inspected, but not quarantined, fiscal year 1910.

Ports of entry.	Cattle.	Sheep.	Swine.	Horses.	Mules.	Goats.	Other animals.
New York				5,948	68		5
Boston	1			181			1
Philadelphia				3	3		2
Baltimore				24			
San Francisco				5			
Portland, Me				58			
New Orleans				10	1		
Mexican border ports	190,616	18,462	1,423	1,892	3,105	6,539	60
Canadian border ports	3,204	98,170	588	6,262	37	16	183
Total	193,821	116,632	2,011	14,383	3,214	6,555	251

TESTS IN GREAT BRITAIN AND CANADA.

The regulations governing the importation of animals subject to inspection and quarantine provide that all cattle 6 months old or over imported from Great Britain, Ireland, and the Channel Islands shall be tested with tuberculin by an inspector of the Bureau of Animal Industry before being exported or after arrival at the animal quarantine station at the port of entry. The following table shows the results of such tests made in Great Britain during the fiscal year:

Results of tuberculin tests in Great Britain of cattle for importation, fiscal year 1910.

Breed.	Passed.	Failed.	Breed.	Passed.	Failed.
Aberdeen-Angus	6	0	Red Polled	13	0
Ayrshire	116	45	Shorthorn	38	10
Dexter-Kerry	42	0			
Guernsey	[1] 842	12	Total	1,929	74
Jersey	872	7			

[1] Thirty-eight of these were for shipment to the United States via Canada.

During the fiscal year 723 cattle were tested with tuberculin for importation from Canada into the United States, 13 of which reacted and were rejected. Of 163 horses tested with mallein, 3 reacted. Two mules were likewise tested with mallein and were admitted.

PREVALENCE AND ERADICATION OF BOVINE TUBERCULOSIS.

The investigations made during the fiscal year 1909 concerning the prevalence and extent of bovine tuberculosis were so well supported by the States that it was deemed advisable to extend them during the past fiscal year. The work for this year shows a great increase in the number of tuberculin tests applied, and includes testing in connection with the eradication of tuberculosis from a State or the locality surrounding a city requiring a tuberculin test for the protection of its milk supply, and testing of cattle at stock yards for interstate

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movement. In cooperating with States and cities it has been customary for them to place veterinarians in the field to work in conjunction with this bureau's inspectors. These investigations have served an excellent purpose in educating the public to the importance of the eradication of bovine tuberculosis as a public-health measure, and have brought many cattle owners to a realization of the economic value of eradicating the disease from their herds.

During the past year the number of States and Territories requiring a satisfactory tuberculin test as a qualification for the entrance of cattle for dairy or breeding purposes from other States or Territories has increased to a total of 35. Unfortunately, in many States there has been no adequate appropriation of funds for the indemnification of owners, the proper enforcement of the laws, or carrying on the work. To assist States in getting the work started, and to avoid delays and inconvenience to shippers, the application of the tuberculin test to cattle by this bureau was undertaken at a number of new points. Toward the end of the fiscal year it was decided that as the interstate tests had given such general satisfaction, the bureau would establish testing stations at the majority of stockyards through which cattle pass and where Government inspection is being maintained, and it was deemed advisable to place the interstate testing of cattle under the direction of the Inspection Division at the beginning of the new fiscal year, as that division already had control of the regular yard inspections.

The following table shows the cooperative tuberculin testing performed during the past fiscal year for the interstate movement of cattle:

Results of tuberculin tests of dairy and breeding cattle for interstate movement, fiscal year 1910.

States.	Number of cattle tested.	Number passed.	Number reacting.	Number of suspects.	Percentage of reactors and suspects.
Minnesota	3,657	3,544	102	11	3.09
North Dakota	1,055	1,041	14	0	1.33
Oregon	809	789	15	5	2.47
Nebraska	773	759	13	1	1.81
Kansas [1]	278	277	1	0	.36
Colorado	224	210	12	2	6.25
Idaho	123	103	9	11	16.26
Virginia	106	94	12	0	11.32
Illinois [1]	45	43	1	1	4.44
Montana [1]	33	33	0	0	.00
Michigan [1]	31	28	2	1	9.68
California [1]	25	25	0	0	.00
Total	7,159	6,946	181	32	2.98

[1] Testing recently inaugurated.

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The following are the tabulated results of tuberculin tests applied by bureau inspectors as a result of cooperation extended to States or cities:

Results of tuberculin testing of dairy cattle for States and cities, fiscal year 1910.

State or city.	Number of cattle tested.	Number passed.	Number reacting.	Number of suspects.	Percentage of reactors and suspects.
Utah	6,321	5,898	332	91	6.69
Kentucky	5,762	5,376	319	67	6.70
Nebraska	5,311	4,815	486	10	9.34
Arkansas	4,988	4,905	59	24	1.66
New Mexico	4,838	4,733	82	23	2.17
Oregon	2,737	2,134	519	84	22.03
Iowa:					
Waterloo	2,697	2,439	233	25	9.70
Idaho:					
Boise	661	646	5	10	2.27
South Dakota [1]	514	495	10	9	3.70
North Dakota [1]	213	182	24	7	14.55
Total	34,042	31,623	2,069	350	7.11

[1] Herds at public institutions.

The tuberculin testing of cattle in Virginia and Maryland, which was started in 1907 in cooperation with the health department of the District of Columbia with a view to obtaining a healthful milk supply for the city of Washington, was continued throughout the past fiscal year. The requests from owners, especially in Virginia, for the application of tuberculin tests to their herds, having spread beyond those herds supplying milk to the District of Columbia, it was decided to extend the bureau's cooperation into other parts of Virginia, working with the office of the dairy and food commissioner of that State and in accordance with the act of the State assembly passed in March, 1910. The owners have been required, in accordance with the custom of the bureau, since the inauguration of the work, to sign an agreement with the bureau for the testing of their cattle, and providing for the proper disposal of reacting animals, the disinfection of premises, and the protection of their herds from the entry of untested stock. The results of tuberculin tests applied to cattle in the States of Virginia and Maryland are shown by the table following.

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Results of tuberculin testing of dairy cattle in Virginia and Maryland, fiscal year 1910.

Item and State.	Number of cattle tested.	Number passed.	Number reacting.	Number of suspects.	Percentage of reactors and suspects.
Cattle not previously tested:					
Virginia	1,100	899	162	39	18.27
Maryland	343	289	48	6	15.74
Total	1,443	1,188	210	45	17.67
Annual retests:					
Virginia	966	923	39	4	4.45
Maryland	309	301	5	3	2.58
Total	1,275	1,224	44	7	4.00

The following is a summary of all the tuberculin tests applied under the supervision of the bureau during the fiscal year in connection with the work hereinbefore reported, also including tests applied in the District of Columbia as hereinafter reported:

Number of cattle tested	45,620
Number apparently free from tuberculosis	42,361
Number of reactors and suspects	3,259
Percentage of reactors and suspects	7.14

This summary, compared with that of the preceding year, shows an increase of 36,811 in the number of cattle tested.

THE ERADICATION OF BOVINE TUBERCULOSIS IN THE DISTRICT OF COLUMBIA.

In cooperation with the Commissioners of the District of Columbia the eradication of tuberculosis of cattle in the District was undertaken in the fall of 1909.

On November 26, 1909, there was issued an "Order of the Commissioners of the District of Columbia for the suppression and prevention of tuberculosis in cattle," which order was approved by the Secretary of Agriculture, and work was begun November 29 by the Bureau of Animal Industry through the Quarantine Division. The principal features of the order were as follows:

Owners of cattle were required to obtain a permit for the entry of cattle into the District of Columbia. When not accompanied by a satisfactory official tuberculin test chart, cattle were to be quarantined until tested within the District. All cattle entering the District for slaughter were required to be tagged for identification, the tag to remain attached to the hide until removed in the presence of a bureau employee. All cattle over 6 months old already within the District of Columbia were required to be inspected and tested with

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tuberculin, and reacting animals were to be slaughtered. Provision was made for the appraisement of reacting cattle, and for partial reimbursement upon a percentage basis, depending upon whether or not the tuberculous lesions found upon post-mortem examination were slight and localized, or extensive and requiring the condemnation of the carcass to the fertilizer tank, the amount received from the sale of the carcass or hide being deducted from the proper percentage of the appraised value, the remainder, if any, being paid to the owner of the cattle. All premises upon which tuberculous animals had been kept were required to be promptly disinfected under official supervision. Provision was likewise made to prevent the illegal entry of cattle into the District and for punishment in case of violations.

In order to systematize the work it was started in the southeastern corner of the District, and a designated area was canvassed with a view to ascertaining the number, location, and ownership of all bovine animals therein. Six veterinary inspectors were then assigned to apply the tests. This method of procedure was followed until the testing of all cattle within the District of Columbia was once covered, namely, to April 2, 1910. Meanwhile all cattle, including calves, entering the District of Columbia from Maryland and Virginia or other States were identified, tagged, and permitted entry in accordance with the order of the commissioners. On March 5, 1910, an amendment was issued to the order of the commissioners, in accordance with which calves under 6 months old and castrated cattle were permitted entry for slaughter purposes without restrictions.

The slaughter of cattle which had reacted to the tuberculin test created an increased demand for dairy cows within the District, and cattle dealers hastened to purchase cattle to supply this demand. Such cattle entered the District after identification and upon a permit and were tested with tuberculin upon the premises of the dealer, who bore the loss of any cattle which reacted without reimbursement. Thus cattle owners were enabled to replace promptly their diseased animals with cattle known to be free from tuberculosis.

After the finding of reactors upon any premises, a satisfactory appraisement was made and the cattle sold, subject to official postmortem inspection, to the butcher submitting the highest bid. Following the removal of reactors, premises previously occupied by them were thoroughly cleaned and disinfected under supervision of employees of the bureau, a strong force pump being supplied for use in this connection. In all dairy barns, bichlorid of mercury, in aqueous solution, 1 to 800, was employed in disinfecting.

Throughout the entire work the cattle owners and dealers cooperated with the bureau.

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The following is a summary of the results obtained within the District in the primary application of the test: The total number of cattle tested in the District of Columbia was 1,701, of which 1,380 passed, and the remaining 321, or 18.87 per cent, were regarded as tuberculous and were slaughtered. Of these reactors, 305 were appraised before slaughter, and for the remaining 16 reimbursement was not claimed, as they were in Government-owned herds. The post-mortem inspections of these carcasses verified the correctness of the tuberculin reaction in 98.36 per cent of the number. Excluding this 1.64 per cent of possible error, 234 carcasses, or 76.72 per cent, showed localized lesions of tuberculosis, which permitted their use for food purposes. The remaining 66, or 21.64 per cent, showed lesions of generalized tuberculosis, the entire carcasses being condemned and converted into fertilizer and other inedible products.

The appraised value of 305 reacting cattle was $13,851.10, being an average of $45.41. The proceeds of sales to butchers were $5,757.08, or an average of $18.88 per carcass. Reimbursement was made to owners on a percentage basis, the reimbursement from available funds of the Department of Agriculture being $4,264.02, an average per cow of $13.97. Owners thus received a total average of $32.85 per cow, or $12.56 less than the average appraised value.

A systematic retesting of all cattle upon premises which had shown infection at the time of the original test was started June 1, 1910, and will be continued during the coming fiscal year.

BOVINE TUBERCULOSIS UPON INDIAN RESERVATIONS.

Upon request of the Office of Indian Affairs of the Department of the Interior, the bureau applied the tuberculin test to cattle at 31 Indian schools and reservations during the fiscal year. In compliance with a further request from the Department of the Interior, a systematic inspection and the tuberculin testing of cattle at all Indian schools and reservations will be conducted during the coming year. Tuberculous cattle will be disposed of under the supervision of this bureau, and general improvement in the construction of buildings and in sanitation, equipment, and methods of handling milk will receive attention.

LIVE-STOCK DISEASES AND CONDITIONS IN PORTO RICO.

During the past fiscal year investigations of the diseases of live stock and the education of native Porto Ricans to the importance of combating the communicable diseases of animals have been conducted by Dr. Thomas A. Allen, bureau inspector in Porto Rico. Little or no action has yet been taken toward the eradication of the cattle fever tick, which infests the native cattle, particularly those of

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the hill country. Blackleg has continued to be an extensive disease of cattle, and is gradually being combated by the use of bureau vaccine. Mycotic lymphangitis and glanders have been reported among the horses of the island.

CONTROL OF ANIMAL DISEASES IN HAWAII.

The suppression and prevention of communicable diseases among animals in Hawaii is under the control of the board of commissioners of agriculture and forestry, division of animal husbandry, with Dr. Victor A. Nörgaard, Territorial veterinarian and an inspector of this bureau in charge of this work.

The isolated situation of the Hawaiian Islands, and the necessity for the introduction of new stock from the mainland, rendered the sanitary control of their introduction a matter of such importance that the Territorial authorities promulgated an order effective January 1, 1910, providing for the inspection of all classes of live stock prior to landing, and requiring the mallein testing of horses and mules and the tuberculin testing of all cattle above the age of 6 months by a qualified veterinarian authorized by or under the supervision of this bureau. As glanders made its appearance among mules after their arrival from California, a special rule requires a quarantine of 21 days, counting from the date of departure from California, of all horse stock arriving in the Territory from that State. For the entry of sheep, certificates by this bureau are required stating that they are free from sheep scab and have been dipped in accordance with bureau regulations. Swine are required to be accompanied by a certificate showing their freedom from hog cholera or swine plague and from exposure thereto.

The problems of tuberculosis and sanitary milk production were given special consideration during the past year, and on March 21, 1910, Honolulu ordinance No. 17 was passed providing for the inspection of milk and dairies and dairy cows and regulating the sale of milk, etc. Under this ordinance it is intended that the tuberculin test shall be applied to all cattle furnishing milk to Honolulu. One thousand three hundred dairy cattle have been tested, 35 per cent of which have given reactions.

LIVE-STOCK DISEASES AND CONDITIONS IN HONDURAS.

During the past year numerous applications were received from representative business men of New Orleans, La., and from cattle growers in Honduras for permission to import Honduran cattle into the United States for beef purposes. As nothing was definitely known concerning the character and extent of animal diseases in that country, and as the Government of Honduras did not possess official

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knowledge concerning the native animal diseases, two representatives of this bureau, Dr. William Thompson and Mr. James E. Downing, were sent to make an investigation of live-stock conditions and diseases in that country. The investigation extended from March 29 to July 7, 1910, and covered all cattle-raising portions of Honduras. Representative ranches in each cattle district were visited, the cattle carefully inspected, and inquiries made concerning any disease which might exist in such locality.

The cattle feed principally on natural pastures, which during the summer or dry season furnish a scanty subsistence. Where cultivation is practiced on the coast land and in the interior small valleys, "guinea" and "para" grass provide a plentiful forage throughout the year. Owing to the mountainous nature of the country, small streams of mountain or spring water abound practically everywhere.

The cattle of Honduras are small, slow to reach maturity, and thin-fleshed, being degenerated descendants of the cattle introduced by the early Spanish settlers. In general, no effort is made toward the improvement of cattle or live stock, and male animals are allowed to roam at will, even those cattle intended for beef not being castrated until 3 or 4 years of age. Steers 4 or 5 years old, grass fed, average about 1,000 pounds live weight, and dress 40 to 50 per cent. The estimated annual net increase among cattle is only 12 per cent, severe losses being attributed to depredations of the leopard, puma, wild cat, and other animals, and to the cattle tick.

As a result of the investigation it was determined that the cattle tick (*Margaropus annulatus*) exists throughout Honduras, and that the losses sustained from the ravages of this tick are serious, the ticks constituting the one great cattle plague of the country. The fact that for a number of years there was a continued and profitable business in the shipping of Honduran cattle to Cuba, where the cattle-fever tick is likewise prevalent, affords confirmatory evidence not only that the tick of Honduras is the cattle-fever tick, but that the cattle of that country harbor in their blood the specific organism of southern or splenetic fever. Further confirmation is afforded by a shipment of nonimmune bulls from Chicago, Ill., to Truxillo, Honduras, all but one of which died from this fever shortly after their arrival.

Blackleg was found to be especially prevalent in the districts of El Paraiso and Olancho. Anthrax, or "morina," apparently exists in various portions of the country, being most prevalent during the months of July and August. Mycotic stomatitis occurs principally toward the end of the rainy season, when vegetation is at its rankest growth. Foot-and-mouth disease and tuberculosis are unknown among cattle in Honduras. Actinomycosis is prevalent in the dis-

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tricts of Vallee and Choluteca. Glanders, farcy, and mycotic lymphangitis were not found among horses and mules.

Gangrenous dermatitis affects the feet of these animals, frequently causing the hoofs to drop off. The natives attribute this condition to the bite of the spider. A few cases of mange were seen in horses and mules. Special investigations were conducted to determine the presence of trypanosomiasis, with negative results. Swine, which are of the long-headed, razor-backed type, act as scavengers, and frequently through their meat convey the *Cysticercus cellulosæ* parasite to man, producing the tapeworm *Tænia solium*.

Exportations of cattle from Honduras to Cuba were made from 1882 to within recent years. This trade has now been totally suspended, due to the complete restocking of Cuba. A small trade in Honduran cattle is being carried on with Salvador, Guatemala, and British Honduras, and it is estimated that should there be a sufficient outlet for cattle 30,000 head of steers could be annually exported.

The presence and prevalence throughout Honduras of the cattle tick, carrying with it the specific organism of southern or splenetic fever, will prevent the importation of cattle from that country into the United States, as such importation is prohibited by section 6 of the act of Congress approved August 30, 1890.

THE PATHOLOGICAL DIVISION.

The Pathological Division, of which Dr. John R. Mohler is the chief, has continued the scientific investigation of animal diseases and other lines of work as heretofore.

LIP-AND-LEG ULCERATION OF SHEEP.

The extensive prevalence of necrobacillosis in sheep under both range and feed-lot conditions has afforded this laboratory excellent opportunities for making interesting observations relative to the causative agent and the transmissibility of the disease. In almost all cases where microscopic lesions suggested necrobacillosis the presence of the necrophorus bacillus was demonstrated either by stained smears or by rabbit inoculations. In some instances it was necessary to resort to other methods. The fact that the malignant form of this disease may arise from the mild form was demonstrated by experiments carried out in the following way: From the warty, inactive form of the disease, as often found in lambs, a pure culture of the necrosis bacilli was obtained from lesions of an inoculated rabbit. This pure culture was inoculated into a second rabbit, and the necrotic muscle from this rabbit when rubbed upon the scarified nose and lips of a wether, ewe, and buck lamb resulted in the production of typical aggravated forms of necrobacillosis. The malady was

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easily transmitted to healthy sheep by the inoculation of scabs from ulcers of the lips of sheep. Smears and cultures made from the lesions produced by experimental inoculations showed necrosis bacilli present in large numbers.

During the past winter inspectors at various slaughtering establishments forwarded for diagnosis cattle livers exhibiting circumscribed yellowish-gray necrotic areas. Smears from such necrotic centers showed them to contain practically a pure culture of the necrosis bacillus. Portions of these beef livers were inoculated upon the lips of sheep and produced characteristic necrotic ulcers. Smears from these necrotic ulcers were teeming with characteristic necrophorus bacilli, thus establishing the experimental transmissibility of this organism from one species of animal to another.

SWAMP FEVER OF HORSES.

The investigation of swamp fever or infectious anemia of horses has been continued. A paper dealing with this disease was published in the Twenty-fifth Annual Report of the bureau and also as Circular 138. From general observations it seems conclusive that aside from the presence of the virus of the disease there are certain changes in the blood of advanced cases of swamp fever that are of extreme importance, but these are of such a nature that no method has yet been devised for their accurate determination. In a broad, general way it may be said that the blood is the real seat of the trouble, and that any pathological changes observed in the circulatory system or in the visceral organs are dependent on this rather than that the lesions in the circulatory system and viscera are primary. The atrophy and weakening of the muscles of the hind quarters, causing the consequent staggering gait, undoubtedly are the result of metabolic disturbances which are inherent in the blood rather than in the muscles themselves. For the present it seems probable that as the disease progresses the animal, in spite of abundant food, a vigorous appetite, and the absence of any noticeable lesions in the alimentary tract, at first loses its ability to lay on fat, and that from this stage it draws on its body fat. This certainly points to a perverted carbohydrate metabolism, and all observations point to the blood as the chief seat of the disturbance. The body fat undergoes a serious atrophy, and this change may account for some of the edemas which are so frequently observed.

An experiment with the trypanblue treatment is still under way.

The conclusion has been reached from the results thus far obtained that natural immunity against swamp fever does exist in some horses. This immunity may be increased by repeated injections of virulent serum from which contaminations have been removed or by means of defibrinated blood.

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An experimental exposure of a healthy horse which was quartered in a stall adjacent to one containing a sick horse for seven months has failed to transmit the disease. The discovery of a trypanosome in the blood of horses in Panama affected with a disease which was diagnosed as swamp fever has been reported, but our observations made in various parts of the United States do not support the results obtained by the writer of the report in question. In fact, the results have been so radically different that the question may well be asked whether both series of experiments have been made upon horses affected with the same disease, although the symptoms and lesions described in both instances resemble those of swamp fever. The equine trypanosomiasis of Panama seems to occupy an intermediate position between the swamp fever of the United States and mal de caderas of South America and to bear a very intimate relation to, if it is not identical with, the Gambian horse disease of West Africa.

CHRONIC BACTERIAL DYSENTERY.

A cow affected with chronic bacterial dysentery, or Johne's disease, was shipped to the laboratory from Pennsylvania and furnished material for further study of the disease. The diagnosis in this animal was confirmed by microscopic examination of rectal scrapings, which revealed the acid-fast organism of this disease in great numbers. The cow was kept isolated in a stable in which several chickens were exposed, in order to determine whether there exists any association between this disease in cattle and avian tuberculosis, as has been asserted by some investigators. It is obvious that such an association of chickens with an affected animal would afford a splendid opportunity for transmission if such were possible. The cow died in an extremely emaciated condition about three months after her arrival, and the post-mortem examination revealed no lesions except the characteristic changes in the mucosa of the intestines. These changes were particularly marked in the ileum. The exposed chickens were killed after the death of the cow and were examined. They showed no lesions whatsoever, and mucous scrapings from different portions of the intestines failed to demonstrate the presence of acid-fast organisms. The histological examination of the affected intestines from the cow showed changes characteristic of the disease, the specific organisms being present in the mucosa and contiguous lymph glands in numerous clumps. Attempts to grow the organism on various culture media failed to give satisfactory results.

BIGHEAD OF SHEEP.

The disease of sheep known to flock masters of certain sections of the intermountain regions of the West as "bighead" has been the

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object of investigation in an effort to learn something of its nature and cause. On account of the fleeting character of the disease and its entire absence in certain years a good opportunity to study it has not heretofore been afforded. However, a number of cases were seen this year by a member of the staff of the Pathological Division, and it is thought that a correct insight of its nature has been obtained.

The localities where this disease is known range in altitude from 4,500 to 8,000 feet above sea level, usually on the plains and valleys between the higher ranges of mountains. Places are known in Idaho, Wyoming, and Utah where it is likely to make its appearance during any of the spring months. It is most often seen in the spring following the melting of the snows or immediately after late snowstorms at that time of the year. As indicated by its name, the chief and characteristic symptom is a very much swollen condition of the head.

A singular feature about this disease is that it is usually confined to certain bands, and that quite a number of animals are simultaneously affected. It occurs only in certain regions of the West, and with more or less yearly regularity, varying, so the stockmen claim, with climatic conditions. There appear to be very definite localities where it is looked for by herders on the trail. The soil of all these regions is of volcanic formation. The flora is also more or less similar, and the climatic conditions are likely to be very much alike.

Post-mortem examinations did not give much information as to the cause. Aside from the edematous infiltrations of the subcutaneous tissues of the head and certain alterations or destruction of the eyes nothing very abnormal was found. From the internal organs of five affected animals culture media were inoculated in an effort to isolate any disease-producing micro-organisms that might be harbored therein, but in no case was a growth obtained except from accidental contaminations from the air.

From the histories of various outbreaks of the disease, as related by a number of intelligent and observing sheep owners and from personal observations, it is certain that many views previously held as to its etiology are wrong. For instance, it does not require a storm to produce the disease; it does not require melting snows to bring on an attack; alkali water does not cause bighead in other parts of the West and is no more likely to produce it in these regions; and gaseous emanations probably have nothing at all to do with it, as emanations of gas have never been proven even to exist. But climatic conditions of a definite character, in combination with certain plants, probably do have the necessary influence to engender the disease, and from observations made this year it would seem that the drinking water had a contributing influence.

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In reviewing the literature of plant poisoning of animals one is struck with the great similarity of this disease to that condition known as fagopyrismus, a disease of the skin and subcutaneous tissues produced by the eating of buckwheat, but requiring the direct rays of the sun to act in conjunction therewith. With this idea in view, an opportunity was afforded at Christianburg, Utah, to put this theory to a test, at least so far as the atmospheric conditions are concerned. In less than two hours three different bands of sheep, 3 to 5 miles apart, all exposed to the same atmospheric conditions and grazing on the same kinds of plants, developed many cases of bighead. All of them had been watered that morning in the Sevier River or in the irrigation ditches flowing from that river. The first band to water and the one farthest away from the stream at the time the sun began to operate had the largest number of sheep affected. This band of sheep had been shorn and was being hurried along on its way to the home lambing grounds. The other two bands were not yet shorn and were being moved more slowly. Several other bands subjected to very nearly the exact conditions on other days developed cases of bighead.

It seems probable that poisonous properties in a certain plant or plants, in combination with certain conditions, may be the causative agent of the disease, and several plants are now under investigation.

GLANDERS.

A great number of specimens, principally nasal swabs, from suspected cases of glanders have been received at the laboratory for diagnosis. The usual bacteriological methods were employed for the determination of the disease.

Besides these routine examinations of suspected cases, experiments were conducted by which an early and reliable diagnosis of latent cases of glanders could be made. In many glandered horses the clinical symptoms of the disease are manifested only at a late stage or not at all, and such unsuspected latent cases must be considered as dangerous in spreading the disease. The mallein and agglutination tests both have their deficiencies, and a more reliable method of detecting incipient and latent cases is very desirable. Following the suggestion of a European correspondent, the bureau is conducting experiments with a precipitation method for the diagnosis of glanders, and the results so far obtained are exceedingly promising and indicate that with its aid an early diagnosis of suspected cases will be possible not only in laboratories, but in the field as well.

ANTHRAX.

In controlling outbreaks of anthrax it is the general practice to use Pasteur vaccines for the purpose of preventing the spread of the infection. As this method requires about one month in which to estab-

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lish protection, efforts have been made to shorten this period by the use of certain laboratory products which consist of a vaccine requiring only one application and an antibacterial serum. In a general way favorable results were obtained in experimental rabbits by the use of certain substances precipitated from nondialyzed cultures, but these all failed when applied to the larger animals. Likewise, an autogenic vaccine had no effect when tested against virulent bacilli.

Numerous experiments have shown, however, that an immediate passive immunity can be conferred by the use of blood from a highly immunized animal, one which will resist 5,000 times the minimal lethal dose of the most virulent strains of anthrax bacilli; also that simultaneous injections of the most virulent strains of bacilli, or of attenuated bacilli, and such a serum, confer an active immunity. Hence by the use of this method an existing outbreak can be checked, or the disease can be prevented, as by the ordinary vaccines. As the serum confers immediate passive immunity, it is not deemed wise to employ virulent bacilli for producing the active immunity, but it is safer to inject simultaneously with the serum the usual Pasteur vaccines, or a single vaccine which corresponds in strength to the No. 2 Pasteur vaccine.

BLACKLEG VACCINE.

During the fiscal year ended June 30, 1910, the Pathological Division prepared and distributed among stock raisers about 1,000,000 doses of blackleg vaccine. The high standard of efficiency of the vaccine prepared by this bureau has been maintained, as is shown by reports made by the stock raisers who have used the vaccine. Reports on vaccine distributed during the fiscal year ended June 30, 1909, show that out of 578,996 cattle reported as vaccinated only 2,242 (0.38 per cent) died. Comparison with previous reports shows a material decrease in the losses from this disease before vaccination, and also a slight decrease in the percentage of losses after vaccination.

RABIES.

Rabid animals have continued to arrive at the laboratory for examination during the year in but slightly decreased numbers from those received during the year before. The number of positive cases received each month shows that the infection has been constantly present in animals of the infected localities.

During the year 116 cases have been examined, consisting of 100 dogs, 7 cattle, 6 cats, 2 mules, and 1 sheep, which had bitten at least 59 persons and 46 animals. Other animals may have been bitten of which no record was made, as a rabid dog in his wanderings across the country is liable to snap at every animal that he may chance to meet, and in many instances these attacks escape observation, yet these are the cases which perpetuate the disease among the dogs of the

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infected regions. Of the 116 suspected cases examined, 75 were found to be positive. The following table gives data regarding these positive cases. It will be seen that 58 of these cases came from the District of Columbia.

Positive cases of rabies diagnosed by the Bureau of Animal Industry during the fiscal year 1910.

Date.	Record No.	Animal.	Source.	Persons or animals bitten.
1909.				
July 7	3209	Dog	District of Columbia	None reported.
9	3210	...d	....do	Several animals.
23	3232	...do	....do	1 boy.
Aug. 13	3258	...do	Virginia	1 woman.
16	3262	...do	District of Columbia	None reported.
16	3264	...do	....do	Do.
19	3274	...do	....do	1 boy.
25	3285	...do	....do	3 people.
Sept. 8	3301	...do	....do	1 dog.
13	3309	...do	....do	None reported.
15	3314	...do	Tennessee	Do.
16	3320	...do	District of Columbia	1 man.
22	3329	...do	....do	None reported.
22	3330	Cow	Indiana	Do.
30	3341	Cat	District of Columbia	2 persons.
Oct. 1	3344	Dog	....do	None reported.
1	3348	...do	....do	1 man.
8	3361	...do	....do	Do.
9	3365	...do	....do	None reported.
Nov. 9	3433	...do	....do	Do.
15	3445	...do	....do	Do.
15	3446	...do	West Virginia	1 child.
23	3466	...do	District of Columbia	1 man.
Dec. 6	3493	...do	....do	None reported.
11	3505	...do	....do	Do
21	3514	...do	....do	2 men.
22	3518	...do	West Virginia	1 woman.
22	3520	...do	District of Columbia	Do.
29	3526	...do	....do	1 man.
1910.				
Jan. 3	3543	...do	....do	None reported.
8	3548	...do	....do	1 girl.
12	3559	...do	....do	2 persons.
12	3560	...do	....do	None reported.
13	3564	...do	....do	11 dogs, 1 cow.
13	3565	Cat	....do	1 child.
17	3568	Dog	....do	None reported.
19	3574	...do	....do	2 persons, 2 dogs.
22	3582	...do	Colorado	None reported.
24	3589	...do	District of Columbia	2 persons.
24	3591	...do	West Virginia	2 persons and a number of dogs.
Feb. 2	3611	...do	District of Columbia	1 dog.
7	3618	...do	....do	1 woman, several dogs.
9	3625	...do	....do	1 boy.
16	3636	Cow	West Virginia	None reported.
23	3656	Dog	Virginia	Do.

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Positive cases of rabies diagnosed by the Bureau of Animal Industry during the fiscal year 1910—Continued.

Date.	Record No.	Animal.	Source.	Persons or animals bitten.
1910.				
Mar. 8	3678	Mule....	Virginia	1 man.
10	3685	Dog.....	District of Columbia	1 dog.
15	3691	...do....	.....do	None reported.
16	3693	...do....	.....do	1 man.
17	3697	Cat.....	.....do	Do.
17	3698	Dog.....	.....do	None reported.
19	3705	...do....	Maryland	1 man.
25	3711	...do....	District of Columbia	None reported.
28	3715	Steer....	Missouri	Do.
Apr. 4	3724	Dog.....	District of Columbia	Do.
11	3737	...do....	.....do	1 man.
11	3738	Cow....	Maryland	None reported.
13	3743	Dog.....	District of Columbia	2 dogs.
21	3756	...do....	.....do	1 woman.
22	3757	...do....	.....do	None reported.
28	3767	...do....	.....do	Do.
May 6	3778	...do....	.....do	Do.
10	3785	...do....	.....do	Do.
11	3788	...do....	Tennessee	1 child.
12	3791	...do....	District of Columbia	None reported.
14	3797	...do....	.....do	Several dogs.
16	3798	...do....	Virginia	Several cattle.
20	3810	...do....	District of Columbia	3 dogs.
24	3822	...do....	.....do	1 boy.
31	3830	...do....	.....do	None reported.
June 4	3845	...do....	.....do	2 or 3 dogs.
18	3855	...do....	Texas	None reported.
20	3857	...do....	District of Columbia	1 boy.
21	3859	...do....	Tennessee	2 children.
29	3872	...do....	District of Columbia	Several dogs.

The diagnosis of rabies in the suspected animals received at the laboratory has been made, so far as possible, by the demonstration of Negri bodies. This method of examination is proving to be very satisfactory, and is used at present in most pathological laboratories where rabies investigations are made.

It is of interest to learn that rabies has been so completely eradicated from Great Britain by the enforcement of muzzling regulations that the pathologists of that country were obliged to send to this country for material from which to make a study of Negri bodies when the discovery was made that the latter bore a most intimate relation to the transmission and development of rabies.

DISEASES OF POULTRY AND OTHER BIRDS.

Routine work has related to the ordinary diseases noted in previous reports. The recent claims of European investigators as to the ultramicroscopic character and identity of the causal agent in so-called

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chicken diphtheria (roup) and epithelioma contagiosum (chicken pox) give interest to the laboratory findings in certain outbreaks during the past year. In a severe outbreak that occurred among a flock of game chickens there were found in all the birds, in stained smears from the necrotic material from mouth, nose, and eye, great numbers of short, medium, and long-beaded filaments of *Bacillus necrophorus.* Isolated in pure culture and inoculated on the scarified buccal mucous membrane of healthy chickens, there resulted only a passing necrotic patch, which vanished in several days. Associated with the necrophorus bacillus in this disease was the polar-stained hemorrhagic septicemia organism *Bacterium avicida*, the recognized cause of fowl cholera. So virulent was this organism that necrotic material inoculated subcutaneously into rabbits resulted in death in three days, and the cultivation of the bacterium from the heart blood, liver, and spleen, readily followed. The site of inoculation was marked by caseo-necrotic material presenting the well-known characteristics of necrobacillosis, although manifestly in such time there could be no typical development of the "necrophorus" lesion. Pure cultures of *Bacterium avicida* inoculated upon the scarified buccal mucous membrane of healthy chickens resulted in a thin yellowish scab and death in three days.

Another outbreak affected almost exclusively the chicks, but two adult birds being attacked. The disease manifested itself by the production of large, dry, cheesy nodules at the base of the comb, about the eyes and angles of the mouth, and on the larynx. The necrotic material in these cases, whether examined in the fresh state or in stained smears, revealed large numbers of coccidial schizonts. All chickens autopsied showed marked evidences of intestinal coccidiosis, while some presented the hepatic form recognized as the blackhead disease.

TUBERCULOSIS.

Tuberculosis has lost none of its importance to the people of the country, and recognizing this fact the Pathological Division has continued its investigations into questions related to its diagnosis and eradication.

One of the most important branches of this work has been concerned with the production of immunity in cattle. It is very evident that the power to immunize cattle safely against all tuberculous attacks would afford the greatest possible assistance wherever attempts were made to eradicate the disease, as all of the healthy animals could receive immunizing treatment and the diseased portion of the herd could be destroyed or quarantined. The experiments necessary for the establishment of any satisfactory conclusions in a study of this character must extend over a long period of time, and

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tests must be made upon many animals of different ages and conditions before any definite conclusions can be reached. While no method of vaccination has yet been devised whereby cattle may be fortified against attacks of tubercular infection under all circumstances, still it has been shown by the cooperative investigations of the Experiment Station and the Pathological Division that their resistance may be materially increased by means of suitable inoculations.

In some of the rare cases in which cattle giving a reaction to tuberculin did not disclose any macroscopic lesions of tuberculosis when submitted to post-mortem examination, glands from the cattle in question have been sent to this laboratory and tested by microscopic examinations or animal inoculations so as to determine the presence or absence of tubercle bacilli. In more than half of such examinations tubercle bacilli have been positively identified when the tissues have been closely examined by laboratory methods, thus showing that tuberculosis was really present in these carcasses, but in the most incipient form. This also shows that the diagnoses given by tuberculin are in reality even more accurate than is indicated by ordinary post-mortem examinations of reacting animals.

EXAMINATION OF MILK.

The question of the presence of tubercle bacilli in market milk has also received careful attention. Milk from the cities of Chicago, Philadelphia, and Washington has been examined at the laboratories of the bureau in each of the above-named cities for the purpose of determining what percentage of the samples tested contained virulent tubercle bacilli. The general bacterial content of these samples was also ascertained.

In Chicago the work of testing milk has been carried on in cooperation with the city department of health. Up to the end of the fiscal year 173 samples of raw milk, 44 samples of pasteurized milk, and 10 samples of certified milk had been submitted to examination. No deductions have yet been made relative to the presence of tubercle bacilli in the pasteurized or certified samples, as the inoculation tests have not yet been concluded.

Two hundred laboratory animals were inoculated with raw milk, one animal being used for each sample of milk. A mixture of cream and sediment from the bottom of the centrifugalizing tubes was inoculated subcutaneously in each case. One case of tuberculosis was found, and this sample was traced to the farm where the milk was produced. Twenty-six cows were furnishing the milk from this place. By consent of the owner the tuberculin test was applied to all of these cows, and three of them gave a positive reaction for tuberculosis.

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At the Philadelphia laboratory 150 samples of raw, pasteurized, and supposedly pasteurized milk, purchased from various milk stores in approximately all parts of the city, were tested. The samples collected were placed in sterile bottles and brought immediately to the laboratory. A microscopic examination and animal inoculations were made from each sample. Three guinea pigs were inoculated subcutaneously from each sample, one receiving cream, one sediment, and the other a mixture of cream and sediment. All animals were kept under observation for two months after inoculation, and at the expiration of this time a careful autopsy was made upon each animal. The autopsies showed that 20 of the samples, or 13.3 per cent, contained active germs of tuberculosis. Microscopic examinations were in all cases negative or indefinite. The examination of the different parts of each sample showed that the cream contained a larger percentage of tubercle bacilli than the sediment. An examination of each sample was also made for the percentage of fat, acid, total solids, the specific gravity, and leucocytic and bacterial content. These examinations showed that much of the milk was of a poor quality.

In the city of Washington the previous work of the Pathological Division showed 2 samples of tuberculous milk out of 73 specimens examined. During the past year examinations were mainly limited to samples from milk sold by dealers who claimed that the product was pasteurized, or that it had been obtained from cows that had passed the tuberculin test without giving any evidence of tuberculous infection. Of about 40 samples only one was found which contained living tubercle bacilli, and this milk came from an untested herd outside the District of Columbia. This result was very gratifying in view of the large amount of work recently done in testing with tuberculin the cows in the District of Columbia as well as the many large herds outside of the District limits whose milk is sold to consumers in Washington. These samples of milk were also examined for the number of leucocytes and bacteria, and in this regard a very satisfactory showing was also made.

EXAMINATION OF "BOB VEAL."

On several occasions recently the bureau's attention has been directed to the practice of certain butchers of placing on the market as edible veal the flesh of immature calves. In view of this practice it is considered very important that more definite information be obtained relative to the age at which calves may be properly slaughtered for veal. Investigations have therefore been started for the purpose of testing the flesh of calves of various ages to see if any harmful properties are present; also to establish the degree in which its tissues are deficient in nutritive value.

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INVESTIGATIONS OF COTTONSEED MEAL.

Laboratory work has demonstrated the presence of pyrophosphoric acid in certain cottonseed meals, and feeding experiments with a simple combination of this acid, such as sodium pyrophosphate, have shown that an amount of this salt which would correspond to even less than would be present in 1 pound of the meal will, if given daily, induce in pigs symptoms closely resembling those seen after feeding cottonseed meal that has been made from the seeds of certain varieties of cotton plants. The pathological lesions thus obtained resemble very closely those seen after similar feeding with such meals. There were only slight quantitative differences. No doubt the base with which this acid is combined in the meal may contribute somewhat to this injurious action.

From the findings of laboratory investigation it seems that cotton seeds vary much in their toxicity. Some are practically nontoxic in their character, but if during the manufacture of meal from the seeds a high temperature is applied to them a poisonous principle may develop. Work is in progress on the identification of the bases with which pyrophosphoric acid is combined. It is important that certain features of this work be repeated under factory conditions.

THE BIOCHEMIC DIVISION.

The Biochemic Division, of which Dr. M. Dorset is the chief, has been engaged during the year chiefly in the laboratory work incident to the meat inspection, in laboratory research work relating to meat products, in investigations concerning hog cholera, in making tests of stock dips, and in preparing and distributing tuberculin and mallein.

LABORATORY MEAT INSPECTION.

The laboratory meat inspection during the past year has been carried out along the same general lines that were followed previously, though the organization of the work has been improved, and the various meat-inspection laboratories have been assigned definite territory, which they are expected to cover, examining samples of all products at reasonable intervals.

During the fiscal year a total of 19,580 samples were examined by the laboratories. These samples consisted of meat food products, salt, spices, condiments, colors, and substances used in the preparation of meats and meat products. Approximately 80 per cent of these samples were from establishments at which inspection is maintained, the remainder being from establishments operating under certificates of exemption.

The results of the year's work show that the use of prohibited preservatives has been practically discontinued in inspected establish-

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ments. Certainly is this true in the case of the larger establishments. Boric acid was found in only 8 samples (sausages), no other preservative being used.

In regard to the adulteration of meat food products from inspected establishments, it has been found that a considerable percentage of sausages contained cereal without this fact being stated on the label. In many instances this is due to ignorance of the packer who uses a proprietary seasoning mixture which frequently consists largely of some cereal flour. In the case of fats and oils, the lards are practically the only products which were found to be adulterated, and these cases of adulteration were extremely rare. In such instances the adulteration sometimes consisted simply in the presence of a minute amount of cottonseed oil (less than 1 per cent), this arising in many cases from the use of the same pipes and equipment for preparing lard and lard substitutes, the latter normally containing cottonseed oil.

The laboratories have examined a large number of coloring materials offered for use in coloring sausage casings and rendered fats. The great majority of coloring materials offered in this way have been rejected on account of the presence of arsenic, it having been decided that no coloring matter should be used on meat food products which contained more arsenic than 1 part in 700,000 of the coloring substance.

A number of inspections have been made of meat food products in order to determine their wholesomeness. This examination applied mainly to the rancidity of fats and oils and to the wholesomeness of certain suspected samples of canned meats. Inspectors have been instructed that in all cases "blown" or "puffed" cans of meat food products should be condemned, the puffing of the cans being due in all cases to the development of bacteria within the can after the process of canning was completed.

During the fiscal year 115 sanitary examinations of packing-house water supplies have been made. The results of these examinations have been to prohibit the use in or on meats or meat food products of 15 water supplies which were found to be of questionable wholesomeness.

RESEARCH WORK ON MEAT PRODUCTS.

The research work in connection with the laboratory meat inspection has consisted in part of the study of existing methods of analysis, in order that these might be improved where possible and that the effect of interfering factors might be more thoroughly understood. In addition, a number of questions arising in connection with the enforcement of the meat-inspection law have been given special study.

A general study has been made of the rancidity of fats and the changes which accompany the development of this condition. The

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general work is far from completed, but opportunity has been afforded for a study of the effect of rancidity on various routine tests which are applied to fats in the course of a laboratory inspection. The Kreis test for rancidity has been studied considerably, and it has been found that it is a reliable indicator of rancidity, but so exceedingly delicate that a certain amount of caution and judgment must be used in drawing conclusions from it. The Halphen test for cottonseed oil has been found to be weakened and the iodin number of fats reduced by the development of rancidity, thus confirming previous observations. The effect of rancidity on the percentage of free fatty acids appears to be in the nature of a reduction at first, and later, after the fat has become strongly rancid, the proportion of free fatty acid increases. The phytosterol test is rendered unreliable by the development of rancidity.

Soy-bean oil is now being used in the preparation of meat food products, especially oleomargarin. A study of the pure oil has been undertaken, but is not yet completed. Enough has been accomplished, however, to enable the laboratories to deal with any attempt to use this oil as an adulterant. Considerable study has also been given to the coloring matter contained in the soy-bean oil. The coloring matter has been separated from the oil and a study made of its chemical properties.

A thorough chemical study of the fat of hogs fed upon cottonseed meal has been made and a report is being prepared for publication. The general results of the work showed that the fat of hogs fed on large quantities of cottonseed meal is abnormally soft and abnormally rich in the glycerids of the unsaturated fatty acids. In confirmation of work carried out by previous investigators the fat of these hogs was found to give the Halphen and Becchi tests for cottonseed oil, but it does not contain phytosterol, thus permitting ready distinction between the fat of this character and fat to which cottonseed oil has been added.

The investigations concerning meat extracts, referred to in my report for the previous year, have been continued and have resulted in the adoption of definite rules governing the preparation of meat extracts at establishments at which Federal inspection is maintained.

An investigation of the action of fats and oils on metals was undertaken primarily in order to determine the effect of fats and oils on galvanized iron, which has been in the past used extensively for constructing containers for lards and lard substitutes and has also been used for lining oleo seeding trucks and for making baker's drums and similar metallic receptacles. As a result of this investigation it was found that practically all metals, zinc in particular, are attacked by fats and oils, and the use of zinc-coated vessels as permanent containers for meat or meat food products in establishments operating

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under Federal inspection has been prohibited. The results of this study have been prepared for publication in the Twenty-sixth Annual Report of the bureau. This study is being extended to include the effect of meat food products in general upon metallic containers. An investigation of solders and fluxes now used in the manufacture and sealing of metallic containers for meat food products, together with a study of the paints used for coating cans, is now under way.

In view of the large number of permitted coal-tar colors offered for use in coloring the casings of sausages, it has been necessary to secure a satisfactory method for estimating any poisonous ingredients in these colors. It has been found that arsenic is practically the only poisonous substance which may contaminate these colors, provided the colors themselves are pure. An extensive examination of this question has resulted in the adoption of a modified Gutzeit test which has enabled the analyst to determine the arsenic with a satisfactory degree of accuracy.

In my last report it was mentioned that the cause of the souring of meats during curing was being studied. This work has been completed and a report of it prepared for publication. The investigations have shown that the souring of meat is due to the action of a specific spore-bearing organism which is properly classified among the so-called anaerobic putrefactive bacteria. In the paper which is to be published a description of this organism is given and suggestions are made which it is hoped will lead to a diminution of the percentage of sour meats heretofore occurring in inspected establishments.

An investigation to determine the effect of prolonged storage on canned meats was begun during the fiscal year. A large number of cans of corned beef, roast beef, and lunch tongue were prepared at one of the large packing establishments. A chemical, histological, and bacteriological study of certain of these cans was made shortly after preparation, and the remainder are being held for examination after the lapse of different intervals of time. It is hoped by this study to determine whether or not any undesirable change takes place in canned meats after the lapse of a number of years.

During the past fiscal year the cooperation of the Biological Survey of the department was secured in a study of the problem of ridding packing houses of rats, and an expert of that bureau visited a number of large establishments at National Stock Yards and Chicago, Ill. A report of his investigation has been used as a basis for instructions to inspectors as to measures to be adopted to destroy and exclude rats.

BRANDING INK.

A systematic effort has been made during the year to improve the branding of inspected meats. A study of branding meats has been made at a large number of the meat-inspection stations, and the result

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has been to increase materially the efficiency of the marking. During the year 4,137 gallons of branding ink prepared by the Biochemic Division were shipped to inspectors in charge of meat inspection. The total cost of the ink, including materials, labor, and containers for shipment, was $2,373.50.

DIPS AND DISINFECTANTS.

The work on dips and disinfectants during the past year has consisted of (1) routine examination of substances used or offered for use in official dipping, and (2) special or research work.

The routine work has consisted in the examination of samples submitted by manufacturers, in the examination of samples of permitted dips which have been sent in by field inspectors, and in the examination of samples of disinfectants for the general supply committee for Government departments located in Washington. A comparatively small number of samples of new preparations offered for use in official dippings have been submitted by manufacturers during the year.

Laboratory experiments in the preparation of a concentrated arsenical dip for the use of the bureau employees in the work of tick eradication resulted in securing a dip which possessed the necessary qualities in so far as the solution itself was concerned, and larger quantities were sent to the field for trial. These field experiments are not completed, but the indications are that the preparation will be satisfactory.

A chemical and bacteriological study of phenolic disinfectants, begun during the previous year, has been continued, but is not yet completed, although decided progress has been made.

Several cases of injury to sheep following dipping in coal-tar creosote and cresol dips were reported during the year, and as the cause of the injuries was not apparent from the reports received, a special detail of a veterinarian and a chemist was made to investigate the cases of injury and study the question at dipping centers where losses had occurred. The results of this investigation indicate that loss after dipping is usually caused by the combined action of a number of different influences, such as the condition of the sheep, the dip, and the handling of the sheep after dipping. If the sheep are unthrifty and weak, either as a result of poor feed or hardship during shipment, they may not be able to stand dipping in a solution which would be entirely without effect on perfectly strong and healthy animals. If the dip is imperfectly mixed, if it is prepared in such a way that it tends to separate or "break," if it is too warm, or if the sheep are kept in too long, injury may result. Generally, however, these factors will not cause serious loss in healthy sheep unless there is a marked "break" or separation of the dip, in which case there is a separation and concentration of the irritating part of the dip. If the

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sheep have been driven long distances, or subjected to physical hardships, loss is more apt to follow than in those which have not been subjected to such treatment. The above facts lead inevitably to the conclusion that in dipping sheep it is essential to perform all operations with extreme care and accuracy.

HOG CHOLERA.

The work in connection with hog cholera has been along the same lines as those pursued during the preceding year, the efforts of the bureau being directed chiefly toward assisting State officials in beginning the work of producing serum for immunizing hogs against hog cholera according to the method successfully developed by the bureau. This has been done through advice by letter and by explaining to State representatives personally at the bureau's experiment farm at Ames, Iowa, the methods of producing the serum and in furnishing a limited amount of serum and a few immune hogs to States that were just starting the work. In addition, a limited number of practical demonstrations have been carried out successfully in Maryland, Virginia, Illinois, Missouri, Iowa, Kansas, Kentucky, and Tennessee. Most of these demonstration experiments consisted in treating a part of a diseased herd and leaving the remainder untreated. At Kansas City, Mo., however, a more thorough test was carried out, the results of which were so interesting and demonstrated so conclusively the efficiency of the serum as a preventive for hog cholera that an outline of it seems desirable.

The test was made in the stock yards at Kansas City, upon the request of the Kansas City Live-Stock Exchange and of individuals interested in this subject. Thirty-five young shoats were purchased from a farm where hog cholera had not existed. These pigs, having been carried to the Kansas City stock yards, and being in charge of a committee appointed by the exchange, were treated as follows: Twenty-two were injected with antihog-cholera serum prepared by the bureau. Four were injected with virulent hog-cholera blood. Nine were not treated in any manner. All were placed in a pen together. As was expected, the 4 pigs inoculated with the virulent blood contracted hog cholera within a short time and all died. The 9 "checks" contracted hog cholera from those which were inoculated with hog-cholera blood, and they also died. The 22 pigs treated with the serum remained well, with the exception of one or two, which were slightly affected on one or two days. It is not certain, however, that the trouble with the immune hogs was hog cholera, as none died. All of the autopsies on the check animals showed typical lesions of hog cholera. No more convincing proof of the efficacy of this serum could be obtained than is afforded by this experiment.

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A considerable amount of experimental work concerning hog cholera has been carried out as opportunity offered. In the previous annual report it was stated that carbolic acid, even in considerable concentration, did not destroy the virulence of hog-cholera blood, although it was sufficient to destroy the ordinary forms of bacteria which are at times present in such blood as contaminations. It was considered desirable to eliminate these foreign bacteria in blood to be used for inoculation simultaneously with the serum, and experiments were carried out with that idea in view. The experiments showed that it was perfectly feasible to protect hogs completely from hog cholera, probably for life, by injecting them simultaneously with carbolized hog-cholera blood and antihog-cholera serum. It is believed that the use of carbolized hog-cholera blood in connection with the serum will be of distinct advantage when simultaneous inoculations are carried out.

Experiments have shown that the virus of hog cholera is not destroyed by a 2 per cent solution of carbolic acid, even after contact with the disinfectant for two weeks. The practical effect of this is to indicate that carbolic acid should not be used as a disinfectant in the outbreaks of hog cholera, but should be replaced by "liquor cresolis compositus" (U. S. P.) in a 3 per cent solution.

The Kansas State Agricultural Experiment Station has published bulletins indicating that it had used with some success as a vaccinating agent blood from a horse which had been injected with hog-cholera blood, it being supposed that the residence of the virus of hog cholera in the body of the horse brought an attenuation of the virus, and that the inoculation with this horse blood, drawn at a given time after inoculation, conferred an active immunity upon the injected hog. The bureau undertook to test this point, and while our experiments have been carried out with only one horse, the results were entirely negative, and it was not considered that we were warranted in pursuing this line of experiment further. We have likewise failed to procure a potent serum by injecting horses with blood taken from hogs sick of hog cholera.

Efforts to determine the nature of the pathogenic agent present in the blood of sick hogs and responsible for hog cholera have been continued, but no positive conclusions have been reached.

TUBERCULIN AND MALLEIN.

Tuberculin for the diagnosis of tuberculosis in cattle was prepared and sent out during the fiscal year to the amount of 349,272 doses, an increase of more than 38 per cent over the amount distributed the year previous. This is undoubtedly due to the increased interest which health officials are showing in the subject of tuberculosis, and also to their recognition of the fact that the tuberculous cow is a seri-

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ous menace to public health. The tuberculin was distributed to State, county, and municipal officials.

Mallein to the amount of 73,346 doses, for the diagnosis of glanders in horses, was also prepared and distributed.

THE ZOOLOGICAL DIVISION.

The Zoological Division, of which Dr. B. H. Ransom is the chief, has continued the investigation of animal diseases of parasitic origin and the study, collection, and determination of animal parasites.

ROUNDWORMS IN SHEEP.

The investigations relative to stomach worms and other roundworms parasitic in sheep have been continued. No new facts of importance bearing on the life history of these parasites, their prevention or treatment, have been discovered.

A zoological study of all the roundworms parasitic in the alimentary tract of ruminants has been completed and prepared for publication. Including newly discovered species, the different kinds of roundworms occurring parasitic in the alimentary tract of ruminants are about 50 in number, and 33 of these have been found in the United States.

GID IN SHEEP.

The first part of a comprehensive study of the gid disease of sheep and the parasite which causes it has been completed and the manuscript sent to the printer. Except for rare cases the disease as yet appears to be limited to the State of Montana, and it is enzootic only in the northern half of that State.

A common opinion that dogs do not eat the brains of sheep because of inability to break through the skull, and hence that the infection of dogs could not come from eating the brains of infested sheep, was proved by experiment to be incorrect. It was found that dogs of the size of an ordinary sheep dog readily extract the brain from sheep skulls, and also that they may in some cases devour nearly the entire bony part of the skull. A report of these experiments is given in bureau Circular 159.

SHEEP SCAB.

A compilation of reports made by bureau inspectors as to the results of dipping sheep under Federal supervision during the calendar year 1909 indicates that lime-and-sulphur and tobacco-and-sulphur dips were much more efficacious than coal-tar creosote and cresol dips. These results are similar to those obtained from a compilation of the reports by sheep owners of dippings done during the

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calendar year 1908. In both instances, however, the number of dippings in coal-tar creosote and cresol dips of which reports were received was rather small, so that it would perhaps be unfair to conclude that these classes of dips are generally less efficacious than lime-and-sulphur and tobacco-and-sulphur dips. Nevertheless the reports suggest that the opinion that the former classes of dips are less reliable than the latter as remedies for sheep scab is not without foundation.

In cooperation with the Kentucky Agricultural Experiment Station a series of experiments in the treatment of sheep scab with tobacco dips was carried out, in order to obtain information as to the effect of the omission of sulphur upon the efficacy of these dips. These experiments showed that tobacco dips without sulphur will cure sheep scab. Whether sulphur may safely be omitted in actual practice remains to be determined.

CATTLE MANGE.

Two series of experiments in the treatment of cattle mange by means of a single application of a kerosene-soap preparation were conducted under the immediate direction of Dr. W. E. Howe, of this bureau. The dip was apparently successful in one series. In the other series it failed to cure all of the cattle in the experiments. It is planned to try the dip again during the coming year, using a higher percentage of kerosene.

Observations were made in Texas indicating that two dippings in an arsenical dip containing an equivalent of about 8 pounds of arsenic trioxid to 500 gallons of dip are insufficient for the cure of cattle mange.

INVESTIGATIONS RELATIVE TO TICK ERADICATION.

A bulletin including the results of two years' investigations relative to the life history of the cattle tick and other points bearing on tick eradication, which were conducted in cooperation with the veterinary department of the Alabama Polytechnic Institute, has been prepared for publication.

Farmers' Bulletin 378, on "Methods of Exterminating the Cattle Tick," was issued during the year.

A bulletin including the results of several years' investigations of arsenical dips as remedies for cattle ticks has been prepared. In this bulletin it is shown that an arsenical dip containing an equivalent of 10 pounds of arsenic trioxid, 25 pounds of sal soda, and 1 gallon of pine tar to each 500 gallons of dip may be effectively used to free cattle from ticks, provided two dippings are given at an interval of from 7 to 10 days.

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An investigation of a proprietary arsenical dip containing on dilution an equivalent of about 8 pounds of arsenic trioxid to each 500 gallons showed that cattle could be almost entirely freed from ticks by two dippings at an interval of 10 days.

In April, 1910, under supervision of an inspector of this bureau, about 2,000 cattle were dipped twice at an interval of 7 to 10 days in an arsenic, soda, and pine-tar mixture, containing an equivalent of 10 pounds of arsenic trioxid to each 500 gallons of dip. Two days after the second dipping a few of these cattle were found to be still infested with ticks. An investigation of this dipping was made. The failure to free the cattle entirely from ticks may be explained as probably due to the fact that the cattle were dipped in a short vat. Many of the cattle had not shed their winter coats of hair, and a thorough wetting of the body was not insured in passing through the bath on account of the shortness of the vat; hence it is not certain that all of the ticks with which they were infested were exposed to the action of the dip. In the light of this experience it is considered advisable that vats less than 40 feet in length at the surface of the dip should not be used for dipping cattle in arsenical dips.

Experiments are now in progress, under the immediate direction of Dr. E. M. Nighbert, of this bureau, with an arsenical dip prepared in concentrated form by the Biochemic Division. A preliminary report indicates that this dip will prove satisfactory in the treatment of cattle for ticks, but a definite statement as to its efficacy can not be made at this time.

INVESTIGATIONS CONCERNING PARASITIC PROTOZOA.

Bureau Bulletin 119, issued during the year, contains the results of investigations concerning certain constituents of normal blood, liable to be confused with parastic organisms, a preliminary report on a trypanosome (*Trypanosoma americanum*) commonly present in American cattle, and data relative to certain other parasitic protozoa.

Investigations relative to the Texas-fever organism have been continued.

INDEX-CATALOGUE OF MEDICAL AND VETERINARY ZOOLOGY.

Parts 24, 25, and 26 of the Index-Catalogue of Medical and Veterinary Zoology have been issued during the year. This catalogue is being prepared under cooperation between the Zoological Division of this bureau and the Division of Zoology of the Hygienic Laboratory of the United States Public Health and Marine-Hospital Service, the Department of Agriculture publishing the author index and the Treasury Department the subject index. Unless unforseen circumstances prevent, the publication of the author index will be completed during the coming year.

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COLLECTION OF PARASITES.

Many new specimens have been added to the collection of parasites belonging to the bureau.

Numerous autopsies on various animals, wild and domesticated, were performed during the year for the purpose of determining the presence or absence of parasitic infestation and the relation of the presence of parasites to the cause of death.

MISCELLANEOUS WORK.

A disease among sheep reported from North Carolina was investigated and found to be due to roundworm infestation of the alimentary tract and lungs.

Losses among a herd of young horses in Virginia during the spring of 1910 were investigated, and the trouble was found to be due apparently to a heavy infestation with lice and roundworms and to insufficient food.

The usual amount of correspondence relative to parasitic diseases and the identification of specimens of parasites was received and replied to.

THE EXPERIMENT STATION.

The general character of the work at the Bureau Experiment Station at Bethesda, Md., in charge of Dr. E. C. Schroeder, superintendent, has been similar during the past fiscal year to that of former years, consisting of independent investigations, investigations in cooperation with other divisions of the bureau, and the provision of facilities for the other divisions to make investigations of a kind that require farm and field conditions not obtainable within the limits of the city. As indicated elsewhere, the new Beltsville farm will provide facilities for experimental work in animal husbandry and dairying, and the work at Bethesda will probably be confined hereafter to veterinary investigations.

TUBERCULOSIS INVESTIGATIONS.

The most important investigations made during the past year related to tuberculosis. An experiment to determine the value of various methods of immunizing cattle against tuberculosis, begun several years ago, was continued and is now about complete. It was found that the methods of so-called bovo-vaccination, devised by Pearson in America and Von Behring in Europe, actually confer a considerable degree of immunity on the treated animals; not an absolute immunity, but an undeniable increased resistance to infection with tuberculosis, which holds out great hope for the results that may be obtained with investigations in the future. At present,

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however, the extensive use of these methods for conferring immunity can not be recommended, as our knowledge about the latency of tubercle bacilli in the animal body, the channels through which the elimination of tubercle bacilli from the bodies of animals into which they are injected for protective purposes occurs, etc., is insufficient to enable us to draw the conclusion that the practice of bovo-vaccination is free from danger to the herds to which it is applied, and, what is of greater importance, free from danger for the persons who use the products derived from the vaccinated cattle. As living tubercle bacilli are employed in all the systems of bovo-vaccination which have, as far as they have been tested at the Experiment Station, given any proof that they are capable of protecting against tuberculosis infection, and as the use of such bacilli can not be regarded as free from danger, it seems that an ideal system of immunization would require the use of some other agent. Some preliminary experiments on a small scale relative to the protective treatment of animals against tuberculosis without the use of living tubercle bacilli have been made at the station, and this subject has been given considerable careful thought and study, but so far nothing of an encouraging nature can be reported.

The method of bovo-vaccination devised by Prof. J. F. Heymans, of Belgium, has been carefully tested with both cattle and hogs, and has been found to be wholly without value. This method, to judge from the claims made by Prof. Heymans, has given excellent results in his own country, where it has been extensively used. These results may possibly be due to a careful supervision of the herds to which the treatment was applied by trained veterinarians. Such supervision would certainly, in the first place, lead to improved hygienic conditions and the removal of all advanced or clinical cases of tuberculosis from the treated herds, and clinical cases of tuberculosis are the most important source for the spread of tuberculosis among cattle, even though apparently healthy tuberculous cattle scatter tubercle bacilli quite freely.

Investigations have been made to determine how much danger there is from the exposure of healthy to tuberculous hogs. These investigations are not yet complete, but as far as they have gone it is seemingly fair to conclude that contact of healthy with tuberculous hogs in a hog yard is not nearly the dangerous source of infection that the exposure of hogs to tuberculous cattle or to the feces of tuberculous cattle has been proven to be.

Some time ago the station proved that the commonest way for tuberculous cattle to expel tubercle bacilli is with their feces through their bowels. It was found that hogs exposed to the fresh manure of a herd of tuberculous cattle very rapidly became tuberculous. In this connection it seemed desirable to gain some information about

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the length of time that tubercle bacilli will remain alive and virulent in cattle feces, and especially in manure piles. Experiments made relative to this matter showed that tubercle bacilli die very rapidly on the exposed surface of manure, but that in the depth of a manure pile they may remain sufficiently virulent for months to cause tuberculosis in hogs that are exposed to the pile after a layer less than a foot thick has been removed from its surface. Hence, as in all the other work done by the station on the vitality and virulence of tubercle bacilli, the fact is here again illustrated that the bacterium of tuberculosis has an enormous amount of resistance to adverse conditions, provided it is not exposed to light or to a temperature which is high enough for the pasteurization of milk. This investigation is not yet fully completed, but we can now say with certainty that tubercle bacilli capable of causing tuberculosis in hogs may live more than three months in a manure pile from a stable of tuberculous cattle.

Some work done in connection with the pasteurization of milk, in which the milk was obtained from a cow affected with udder tuberculosis, showed that a temperature of 60° C. (140° F.), maintained for 20 minutes, invariably killed the tubercle bacilli. Over 100 guinea pigs injected with such pasteurized milk remained free from tuberculosis, while an equal number injected with unpasteurized milk from the same source contracted generalized tuberculosis with very few exceptions.

An experiment is still in progress relative to the elimination of tuberculosis from a herd of tuberculous cattle, and the derivation, in the most economical way, of a herd of sound cattle from one that is affected with this disease. It will be some time, however, before a report on this work can be written. At present we can say that congenital tuberculosis among calves is very rare unless they are produced by cows affected with very advanced tuberculosis, and that calves rarely contract tuberculosis during the first few weeks of their lives from exposure to their dams when the later are not clinically affected and have sound udders. Milk from a tuberculous udder means the rapid and practically certain infection of all calves that drink it.

Among a number of tuberculous cattle kept for a long time at the station one observation is of considerable practical importance. It seems that when tuberculous cows are kept any length of time after the disease is somewhat advanced or has become clinically determinable, the development of udder tuberculosis and the extreme infection of the milk with tubercle bacilli is very common.

During the year a fairly large number of samples of commercial butter were tested for tubercle bacilli. The tests, among other things, showed that commercial butter varies greatly as to the amount of

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water, curd, salt, fat, filth, bacteria, etc., which it contains. Six of the samples examined were found on microscopic examination to contain acid-fast bacteria that were indistinguishable, optically, from tubercle bacilli. Guinea-pig injections with samples of the butter caused tuberculosis in only one instance, but the injection tests were made with such very minute quantities that they can not be said to have given wholly reliable results. This investigation will be repeated and an effort made to distinguish between butter derived from raw and from pasteurized cream.

A number of samples of commercial tuberculin were tested to determine whether they were of sufficient potency for use as diagnostic agents for cattle tuberculosis. It is gratifying to say that all the samples tested were found to be satisfactory.

For the new year it is planned to make a careful test of the different methods of applying tuberculin to animals for diagnostic purposes, not with the idea that some other method will give better results than the subcutaneous injection which, when honestly and properly applied, has an accuracy that we can not reasonably hope to exceed, but mainly with the idea that some method for applying tuberculin may be found which will answer as a check against those frauds which are at times practiced by unscrupulous dealers in cattle to prevent a reaction from tuberculin even though tuberculosis is present.

An attempt has been made, by feeding guinea pigs with pasteurized milk from cows affected with udder tuberculosis, to determine whether the dead tubercle bacilli in such milk have an injurious effect on the body. This investigation has not yet given results of a sufficiently definite character to be reported. An effort will be made to study the possibly increased or reduced resistance to tuberculous infection which may be associated with the use of pasteurized infected milk.

OTHER WORK.

Hog diseases, Texas fever, cattle ticks, cattle-tick dips, blackleg, glanders, swamp fever, tetanus, cattle mange, infectious abortion, the internal and external parasites of sheep, rabies, and a number of other subjects have received more or less attention at the Experiment Station.

In addition to cooperative breeding investigations, the experiment station has provided the Animal Husbandry Division and other divisions of the bureau with extensive facilities for independent investigations. As during former years, large numbers of small experiment animals and a large amount of forage were raised at the station, and a considerable quantity of material in the form of blackleg meat, normal and other sera, milk, etc., were supplied to the city laboratories of the bureau.

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THE ARMY REMOUNT PROBLEM.

By George M. Rommel,
Chief of the Animal Husbandry Division.

INTRODUCTION.

The mounting of troops in an army is a most serious problem. Not only must provision be made for a supply of horses sufficient to equip the mounted service for the ordinary routine work during peace, but horses multiply slowly, and a reserve must be provided for use in case of an outbreak of hostilities. In the solution of this problem the European countries, with the exception of England, have for more than a century expended large sums of money in the encouragement of horse breeding, by maintaining breeding farms, by granting subsidies to stallions, by prizes for horses of suitable type, and by grants to breeders' associations, prizes for racing, etc. England has heretofore been content to rely upon the resources of her colonial possessions and the United States for such horses, but her experience in the Boer War 10 years ago, when she was forced to drain North America of a large proportion of the horses suitable for military purposes, has compelled her to accede to the demands of the army, and a grant of $200,000 has been made by the Board of Agriculture to encourage the breeding of military horses at home. That the United States faces a similar condition is a very widespread opinion.

HORSE-BREEDING METHODS IN EUROPE.

THE GERMAN EMPIRE.

Germany probably makes larger total expenditures for the encouragement of horse breeding than any other country, and of all the German States most attention is devoted to the subject in Prussia. The Prussian Provinces not only supply horses used in the army in Prussia, but in Bavaria, Saxony, Wurtemburg, and other parts of the Empire.

There are 5 breeding farms and 18 stallion depots in the Kingdom of Prussia, the farms containing a total of over 20,000 acres. The breeding work of the Government is partly to encourage live-stock raising in general, as well as for military purposes, although there are two Provinces in Prussia known as the "remount Provinces," where only the military object is considered by the Government.

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The stallion depots (Landgestüte) are most important from a numerical standpoint, and contained 3,315 stallions in 1907. These stallions "make the circuit" from February to June, at fees ranging from $1.19 to $4.76.

The Prussian Government does not permit expense to stand in the way of acquiring the services of a valuable stallion. Large sums are appropriated annually for such purposes, and Derby winners are bought if needed. The budget of 1907 for the purchase of horses amounted to $440,000, with a special fund of $47,600. Among noted English Thoroughbreds which the Prussian Government has bought were the Derby winner of 1897, Galtee More, for which $66,640 was paid, and Ard Patrick, the Derby winner of 1902, for which $100,000 was paid.

FRANCE.

The breeding system of the French Government is especially interesting to an American on account of the large numbers of French horses which have been exported to this country. Although the work is done entirely by the Ministry of Agriculture, it is largely affected by military considerations. The French Government has a breeding farm at Pompadour of 1,122 acres where horses are bred, a sheep farm of 619 acres in connection with the agricultural school at Grignon, and the famous sheep farm at Rambouillet. Aside from these the breeding work is done through the medium of the "haras" or central studs, 22 in number, from which stallions are distributed throughout the country. In 1906 the French Government owned and used for breeding purposes 3,321 stallions, which covered 161,414 mares at an average fee of $1.47. The breeds used were as follows:

Thoroughbred	229
Arab	100
Anglo-Arabs	234
Half-blood (Demi-Sang)	2,208
Draft horses	550
Total	3,321

The Government also encourages horse breeding by examining and approving or disapproving privately owned stallions for breeding purposes, by giving prizes at horse shows, encouraging racing, and maintaining the studbook for Thoroughbreds and half-breds. During the year 1906 $1,718,129 was voted by the Chamber of Deputies for the improvement of the breeds of domestic animals, but more than twice this amount was spent, the balance being covered by the receipts from race tracks and other sources.

AUSTRIA-HUNGARY.

The efforts of the Austro-Hungarian Government to improve the condition of horse breeding and other forms of the live-stock indus-

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try surpass those of all other countries in one respect—the magnitude of the breeding farms—in addition to which large numbers of stallions are placed at convenient stations during the breeding season, as in other countries. In Austria proper there are two state horse-breeding establishments, with farms in connection, leased by the Ministry of Agriculture. These are the one at Piber of 1,000 acres and the one at Radautz with 23,809 acres. The entire Government expenditure in Austria in 1907 was $938,000. This work is very largely dominated by military considerations. In Hungary are the great establishments of Mezöhegyes with over 50,000 acres of land, 2,000 horses, and 6,000 employees; Kis-Ber with over 18,000 acres of land; Babolna with over 10,000 acres; and Fogaras. In addition there are a number of stallion depots and two studs which breed horses solely for the Emperor's stables. With all this great outlay the Government it not able to supply the army, and over half the horses used are bred by private individuals without any assistance from the Government. The privately bred horses, however, are not so uniform in size and gait as those bred under Government supervision. The great estates of the Hungarian Government are not devoted entirely to raising horses, but large numbers of cattle and other animals are raised as well for public benefit.

ITALY.

The Italian Government does not devote so much attention to horse breeding as those already mentioned, but 640 stallions stood for public service in 1906, covering 29,462 mares.

PURCHASING REMOUNTS IN EUROPE.

In purchasing remounts, purchases are almost uniformly made in the open market, the purchasing board presenting itself at localities within a given district at stated times and making selections from among the horses offered. In Germany, for example, in 1910, 27,462 horses were offered of which 13,660 were bought. The prices ranged as follows:

Prussia	$253
Bavaria:	
3-year-olds	243
4-year-olds	310
Saxony:	
Young horses	254
Older horses	321
Wurtemburg:	
Young horses	253
Older horses, from Prussian remount depots	368

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ARMY HORSES IN THE UNITED STATES.

Next to Russia, the United States leads the world in the number of horses which it possesses. These horses, as everyone knows, are the descendants of horses brought from the Old World after the discovery of America by Columbus, as there were no horses on the American Continent at that time. Prior to the Civil War the horses of the United States were of the light type, with one prominent exception—the Conestoga draft horse of Pennsylvania, whose origin has always been shrouded more or less in mystery and whose complete disappearance was a remarkable result of the development of railway transportation. There are also a few minor exceptions. Well-authenticated evidence shows that a few draft horses were imported from France in the thirties, and the draft stallion Louis Napoleon, imported from France in 1851, appears often in the pedigrees of Percheron horses in the United States.

ARMY HORSES OF THE CIVIL WAR.

At the time of the Civil War, however, the horses of the United States contained so little cold blood that it was a negligible factor. The Morgans in New England, Standardbreds in New York and the Middle West, Thoroughbreds in Virginia, and saddle horses in Kentucky, Missouri, and Tennessee, predominated and made up the bulk of the splendid mounts of the contending armies of that great struggle. Even the much-despised plains horse (the mustang, cayuse, or broncho) was the descendant of warm-blooded horses and doubtless contributed his share to remounting the cavalry of both the Northern and Southern forces in the Civil War. The demands of these troops for remounts were enormous, but there does not seem to have been any insurmountable obstacle to the acquisition of these horses. They were in the country, they answered the purpose, and they were obtained when needed.

Unfortunately, the photographs of the cavalry and horse artillery of the Civil War are disappointing to the student desiring information on the character of horses on which troops were mounted. A careful search of the Brady collection in the War Department fails to show any photographs of mounted cavalry, but there are a few photographs of horse artillery which show fairly well the character of the horses then in service in the Northern Army, two of which are presented herewith (Pls. I and II). The imperfections of photography in those days made it impossible to catch the motions of animals exactly, but the illustrations are sufficiently clear to show that the mounts of the two batteries shown were horses of light type—warm-blooded horses. Draft blood is not apparent.

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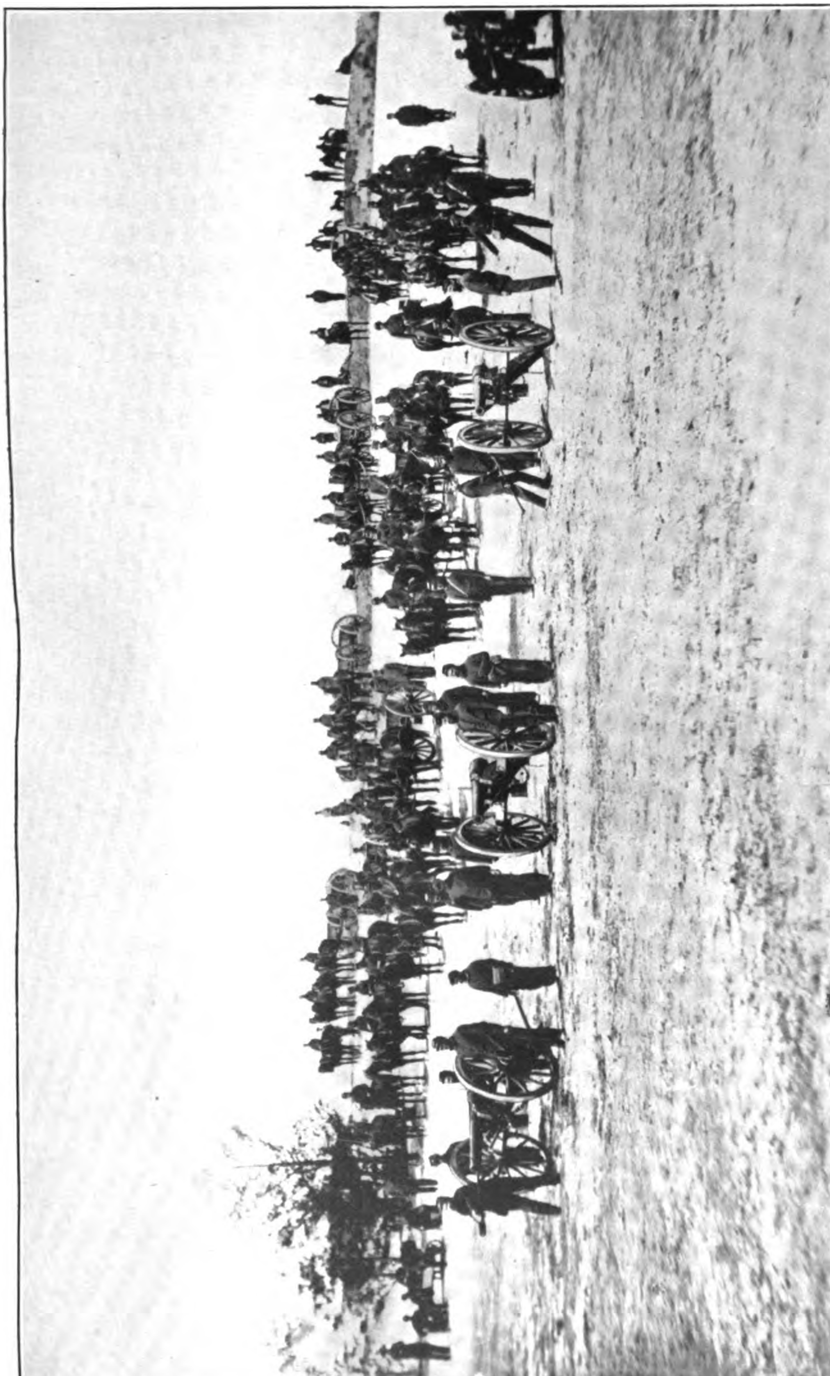

ARMY REMOUNTS IN THE CIVIL WAR. RINGGOLD'S BATTERY, UNITED STATES ARMY, ON DRILL.

(From the Brady collection of photographs in the War Department.)

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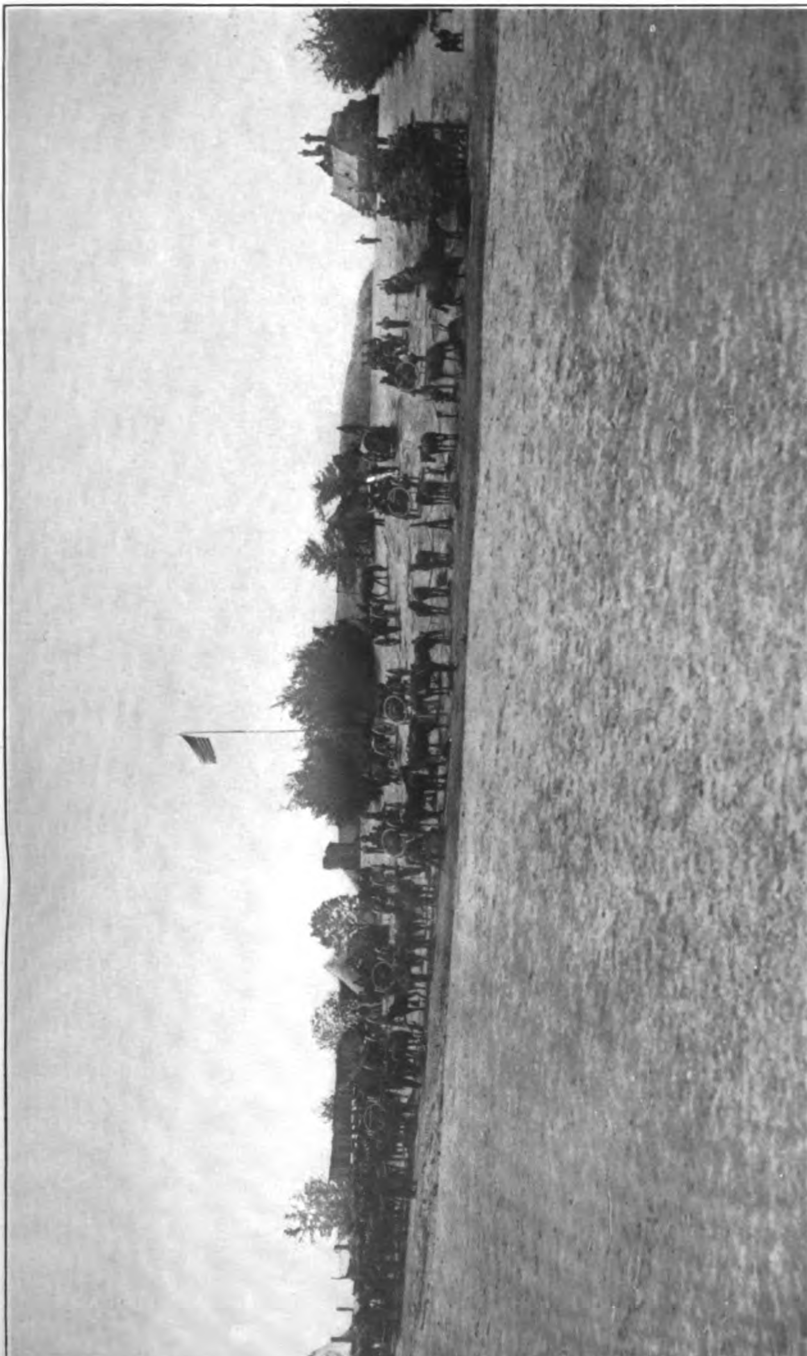

ARMY REMOUNTS IN THE CIVIL WAR. BENSON'S BATTERY, UNITED STATES ARMY, IN CAMP.

(From the Brady collection of photographs in the War Department.)

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The cavalry of the Southern Army was almost as numerous as that of their opponents, and the consumption of horse flesh was probably nearly as great. Yet the Southern troops were even better mounted than those of the North.

THE DEVELOPMENT OF THE DRAFT-HORSE INDUSTRY.

With the close of the Civil War began the rapid importations of draft horses from Europe, and this trade has flourished until the present time, with the exception of the period of depression during the middle nineties.

In the corn belt and in the irrigated sections of the West the draft horse is becoming the farmer's horse almost to the exclusion of horses of the light type, and rightly so. Where conditions of environment are satisfactory a farmer is wise to use draft horses because he can haul larger loads, get greater power for moving heavy implements, and suffers a minimum loss from blemishes when he markets his surplus. In some parts of the country, where a prosperous farmer formerly kept a fine team of drivers to get about over the country, the drivers have been discarded and the farmer now owns an automobile of moderate price. Even in the South, where the prolonged hot season undoubtedly works to the disadvantage of drafters, such horses are gaining a foothold.

That the lines are being closely drawn between the sections producing draft horses and those producing light horses is clearly shown by the reports of the stallion registration boards in those States which have adopted legislation requiring stallions to be licensed before being permitted to stand for public service. The following table shows the number of purebred stallions of draft and light type and ponies standing in 11 States, and an estimate of the purebred horses in New York, according to the latest information available, with the percentage of each type:

Purebred stallions in various States.

States.	Light.		Draft.		Pony.		Total number.
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	
Illinois	1,608	31.70	3,408	67.19	56	1.10	5,072
Iowa	1,121	17.92	5,116	81.78	19	.30	6,256
Kansas	701	27.02	1,884	72.63	9	.35	2,594
Minnesota	252	17.51	1,184	82.28	3	.21	1,439
Montana	175	38.46	280	61.54			455
Nebraska	204	18.66	881	81.15	2	.18	1,093
New York [1]	865	57.59	361	24.03	276	18.38	1,502
North Dakota	114	11.39	886	88.51	1	.10	1,001
Pennsylvania	367	45.70	434	54.05	2	.25	803
South Dakota	165	13.43	1,062	86.41	2	.16	1,229
Utah	56	19.93	225	80.07			281
Wisconsin	436	32.68	894	67.02	4	.30	1,334
Total	6,064	26.30	16,621	72.08	374	1.62	23,059

[1] A partial list. New York does not have a stallion registration law. The information is from Bulletin 17, New York Department of Agriculture, and includes both sexes.

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This table shows the figures for purebreds only. One can usually depend on a purebred stallion reproducing his type pretty accurately; no one knows what a grade stallion is likely to "throw."

The table shows emphatically that the draft horse is easily the more popular horse in nearly every State where figures are available, the percentage ranging from 24.03 in New York to 88.51 in South Dakota. Even in Pennsylvania, where conditions are not as a rule favorable to draft horses on account of the hilly and mountainous character of much of the State, over 50 per cent of the purebred stallions are drafters. In Wisconsin, Illinois, Iowa, Kansas, Minnesota, Nebraska, North Dakota, South Dakota, Montana, and Utah, where the light horse was formerly the preferred type, and from which section most of the remounts for the Army once came, the percentage of purebred stallions of the light type is as low as 11.39, and does not exceed 39 per cent. At the time of the Civil War there probably was not one draft stallion in all this territory, and this remarkable change has therefore been the result of less than 45 years growth. One can only wonder what the next 45 years will bring forth.

MILITARY HORSES IN THE UNITED STATES TO-DAY.

The argument is frequently advanced that if the War Department were to pay sufficient prices for horses it could easily obtain the number needed for the use of the Army. This argument is not exactly apropos. Under the remount system now in vogue, whereby the Government buys young horses direct from farmers, the supply necessary for the Regular Army on its present peace footing is being obtained in a fairly satisfactory manner, as the photographs of remounts accompanying this article will show. (See Pl. IV.) However, the Government is concerned in the encouragement of a supply of horses which will be profitable to those who raise them and which may be drawn upon in case of war. The well-worn dictum that preparedness is half the measure of success in a conflict applies no more to the subject of rifles, guns, and fortifications than to that of horses for the mounted service. A supply of horses sufficient to equip a modern army can not be picked up in a few weeks where it does not exist, and suitable horses can not be bred and raised to a usable age in much less than 6 years. We have already observed the sweep of the draft horse over the United States—a perfectly normal matter, based on sound economic laws. But an army can not be mounted on drafters if it is to use its cavalry and field artillery to good advantage.

POLICE REMOUNTS.

The success of the police departments of our large cities in providing their mounted men with good horses is always brought up to

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show that a sufficient price will always provide sufficient horses of good type.

According to the census bulletin of 1907 giving statistics of cities there were in that year 1,106 patrolmen mounted on horses in the various city police departments. Of this number, 559 were in the cities of New York, Chicago, Philadelphia, St. Louis, and Boston. The total number of mounted policemen in the entire country, therefore, just about equals the enlisted strength of a regiment of cavalry on a war footing.

The authorized number of mounts for the Cavalry of the Regular Army on its present peace footing is 11,970, and on a war footing 17,100. The mounted police are practically comparable to the Cavalry on a war footing, and, therefore, the Army, on the basis of 15 regiments of Cavalry, requires over 15 times as many horses as the entire combined mounted police force of the United States.

Letters of inquiry sent out to the police departments of the cities named and that of Washington, D. C., elicited the following information for the year 1911, which, of course, shows some variation from the figures quoted above from the census bulletin:

Horses used by mounted police, six cities, 1911.

Cities.	Number of horses used by mounted police.	Number of horses purchased annually.	Breeding.	How purchased.	Price per head.
New York	464	75	Mainly trotting bred; some Thoroughbred blood.	Contract	$372.50
Chicago	50	5	Unknown	Various persons	225–250
Philadelphia	282	50–60	"Western bred"	Contract	210
St. Louis	70	Indefinite; 6 in 1911.	"Northern bred"	At National Stock Yards, Ill.	190–245
Boston	30	4	Unknown	Different dealers	325
Washington	57	Not known; each officer buys his own.	do	Various persons in District of Columbia, Maryland, and Virginia.	225

The information for the New York mounted police is particularly enlightening, as that body of men has a well-deserved reputation not only for horsemanship but for the excellent quality of its mounts. The department expects to purchase about 75 saddle horses in 1911 at a cost about twice as much per head as the cavalry remounts are now costing the Government under the remount system. This contract has been held for several years by one firm, which does a very extensive business in all kinds of horses and has buyers in various parts of the country where good horses are found. These buyers are familiar with the specifications of the New York police department and have instructions to buy horses when they find them conforming to those specifications. The horses selected come mainly from Indiana and

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Missouri, and are said to be principally of trotting-bred stock; some are grade Thoroughbreds. Only about half the horses purchased are accepted by the police department, but the supply firm has no difficulty disposing of the others for general purposes. If this statement means anything, it means that, even at a price of nearly $400, it is not an easy matter to get enough horses to supply New York's apparently small demand of 75 head per year; and it is evident that if, under present conditions, the Government undertook to mount the regular cavalry as well as the New York police are mounted, it could only be done at tremendous cost, if at all.

For the information of the reader, the New York police contract specifications for saddle horses for 1910 are inserted here:

SPECIFICATIONS FOR SADDLE HORSES PURCHASED DURING 1910 FOR USE BY NEW YORK MOUNTED POLICE.

The police commissioner reserves the right to reject any or all horses not absolutely sound, or which may be determined by him to be unsuitable for the department service.

Each horse must remain on trial in the service of the police department for a period of 30 days, during which time he will be used for police service, in the discretion of the officials of the department. He will be so held at the risk of the contractor, and in case of sickness or injury during such trial service, he will be held in like manner for such additional days as may be required to fully develop the capacity of the horse for police service. Any horse failing to meet the requirements during such trial will be immediately removed and replaced as often as may be necessary to procure a horse perfectly satisfactory in every respect.

All horses to be geldings of good conformation, sound, well broken, prompt and light in movement. They must be handsome animals, bay color, black points, intelligent, tractable, showing breeding and superior class, and in all respects suitable for the police service as determined by authorized officials.

Saddle horses must be sound, well bred, of a superior class, and have quality; gentle and of a kind disposition, with light and elastic mouth, easy gaits, free and prompt action at the walk, trot, and gallop; free from vicious habits, without material blemish or defect, and otherwise to conform with the following description:

Horses to be gelding, solid bay, with black points, in good condition, from 5 to 8 years old, weighing not less than 1,050 pounds and not more than 1,100 pounds.

Height not less than 15½ hands or more than 16 hands high.

Head small and well set on neck; ears small and erect; forehead broad and full; eyes large and mild, vision perfect in every respect; muzzles small and fine and branches of under jaw (adjoining neck) wide apart.

Neck light, moderately long, with crest firm and longer than underside.

Withers elevated, well developed and muscled.

Shoulders long, oblique, and well muscled.

Chest full, deep, moderately broad and plump in front.

Back short, straight, and well muscled.

Loins broad, straight, very short, and muscular.

Barrel large, increasing in size toward flanks, with ribs well arched and close together.

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Limbs: Forearm large, long, heavily muscled; hind quarters wide, thick, very long, full, and rounded externally; stifle large and well muscled, and hocks lean, large, wide from front to rear, and well situated; pasterns strong, medium length, not too oblique, and well directed.

Feet medium size, circular in shape, sound, of fine texture, sole concave, frog well developed, sound, firm, and healthy.

Each horse will be subjected to a rigid inspection, and any animal that does not meet the above requirements will be rejected.

The fact that the police departments of our cities are able to mount their men without resort to any plan to encourage the breeding of horses of the particular type desired has no bearing on the Army remount problem, on account of the small number required for the police. The Army could, by using a plan similar to that of the New York police, place men in various parts of the country to pick up desirable horses as opportunity offered, and this is practically what is now being done in supplying the remount depots. On account of the larger numbers required and the inevitable necessity of keeping in mind the supply of good horses in case of war, these officers are strongly impressed with the desirability of educating horse raisers to breed intelligently and to use methods which will insure as much as possible reasonably profitable results. As Congress has expressly forbidden the War Department to expend any of its appropriation for breeding purposes, the dilemma in which officers find themselves may readily be seen.

MOUNTED SERVICE IN THE MILITIA.

Next to the police in intimacy of contact with the public is the mounted militia, and this subject may be passed briefly. If it is difficult to obtain the proper horses for the mounted police and the Regular Army, it is many times more so to get satisfactory mounts for the militia cavalry and artillery.

Squadron C (Brooklyn), New York National Guard, has taken quite a step toward solving this problem by maintaining a breeding farm, where some of the remounts needed are bred, and where horses owned by the squadron may be turned out if necessary. Squadron A occupies an armory in Manhattan, where the horses it owns are kept, but these represent only a part of the horses needed by the squadron; some are owned by the members, but many more are rented as needed.

The rented militia horse is not only a source of pain and discomfort to his rider, but is an expense to the State, which is usually out of proportion to the service rendered. When the encampment is over, the horse goes back to his owner and the Government has no claim on him if he is needed again. These horses are frequently poor livery hacks, untrained to work in mounted organizations, and would be decidedly unsatisfactory in real warfare. Further, it is only by

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paying very high rates for their rental that they can be obtained even for an ordinary, peaceful encampment. Anyone who has visited or participated in a militia encampment in which mounted militia were engaged, and has seen the curious mounts provided for such troops, will readily appreciate the difficulty of obtaining really satisfactory remounts for this purpose.

MOUNTED SERVICE IN THE UNITED STATES ARMY.

The mounted service in the Regular Army is now being supplied with horses which are bought young, developed and trained in the remount depots, and issued to troops at 4½ to 5 years of age, properly trained and ready for work. The remount depots were first established in 1908, and already the wisdom of Congress is apparent in permitting the War Department to use abandoned military posts for this purpose. As will be shown under the next head, the horses for the depots are purchased by officers direct from farmers, and the middleman's profit under the old contract system is eliminated, the breeder receiving the money which the Government pays for the horse.

The War Department is now paying about $150 for 3-year-old unbroken colts, and somewhat less for 2-year-olds. The writer is permitted to make the following quotation from a recent letter from the officer in charge of the Fort Reno Remount Depot to the Quartermaster General concerning two lots of 2-year-old colts purchased in 1910 in Texas and Wyoming:[1]

> These colts are now 3 years old, and have in my opinion made satisfactory growth.
>
> The average height of the Texas colts is 14.3; average weight, 796 pounds; average growth in the year, 3 inches; average increase in weight, 115 pounds. By the time they are 5 years old, with the exception of probably 8 head, the average height should be 15.1 or over, and weight 1,000 pounds or over.
>
> The average height of the Wyoming colts is 15 hands; average weight, 864 pounds; average growth about 2 inches; increase in weight, 48 pounds. Practically all this gain has been in the last few months. These colts at 5 years of age, with the exception of probably 3, should average well above 15.2, and weigh 1,050 to 1,100 pounds.
>
> The Texas colts cost $80 per head, and the cost of forage from the date they were received (June 6, 1910) to June 1, 1911, was $32, making the cost of the colt to the Government when 3 years old $112.
>
> The Wyoming colts cost $100 per head, and it has cost $25 per head to forage them from August 30, 1910 (date of receipt), to June 1, 1911, making the cost of the colts at 3 years of age $125.
>
> Cost of the Missouri and Virginia horses at 3 years is $150 to $164.

The mounted service still contains a large number of unsatisfactory horses purchased under the contract system, and it will naturally be some time before all the horses in the Army will have been received

[1] See Plate IV for typical illustrations of these remounts in the rough.

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FIG. 1.—A REMOUNT OF THE NEW YORK MOUNTED POLICE. THE BEST MOUNTED ORGANIZATION IN THE UNITED STATES.

FIG. 2.—CHICAGO MOUNTED POLICE.

MOUNTED POLICE HORSES IN THE UNITED STATES.

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FIG. 1.—HALF-BRED VIRGINIA REMOUNT, PURCHASED BY AN OFFICER.

FIG. 2.—TROOP HORSE IN B TROOP, FIFTEENTH CAVALRY, FROM FORT RENO STATION.

TYPE OF HORSE NOW BEING ISSUED TO TROOPS IN THE UNITED STATES ARMY FROM REMOUNT STATIONS.

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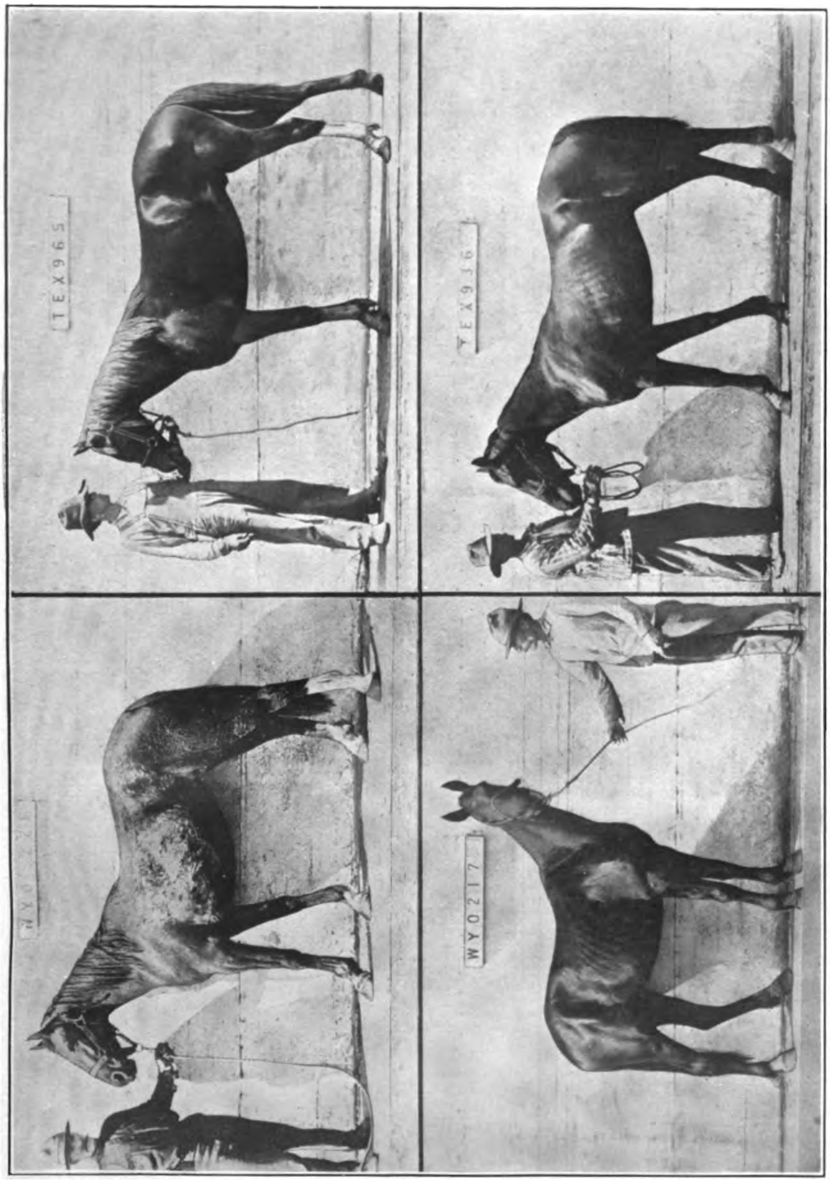

HORSES AT FORT RENO REMOUNT STATION SHORTLY AFTER ARRIVAL FROM PURCHASING OFFICERS.

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from the remount depots. The system is satisfactory and adequate for the present peace footing, but what the country would do in case of war can only be conjectured.

WHAT WAR REQUIREMENTS MEAN.

The following table gives a slight idea of the difference between supplying the present demand of about 2,000 horses per year and the demands of war. It shows the number of remounts of all kinds required by the Regular Army and militia on a war footing, excepting draft horses and animals for wagon trains, some of which might be replaced by motor vehicles:

Total authorized animals, mounted service, Regular Army and militia, war footing.[1]

Class.	Regular Army.	Militia.	Total.
Cavalry	17,100	6,840	23,940
Artillery	4,708	9,108	13,816
Engineers	249	456	705
Signal	425	1,656	2,081
Hospital	692	439	1,131
Orderlies	620	480	1,100
Officers	3,352	2,262	5,614
Total	27,146	21,241	48,387

[1] From Quartermaster General's Office, War Department.

This table shows that on a war footing 50,000 horses (in round numbers) would be required before a shot was fired or a saber drawn, as against 20,000 horses now in the Regular Army on a peace basis. The number is regarded as conservative, as the figures show the minimum needed. The fact that new mounted organizations are constantly being formed in the militia will soon make these figures considerably under the mark.

On the basis of a 10-year life for a horse in the mounted service, under the remount system there should be available annually at least 5,000 horses to supply both the Army and the National Guard, but in war we can not count on a 10-year life. The decimation of horses in war is enormous and must be provided for if a country's mounted service is to be properly equipped. How much this should be the writer does not pretend to estimate. The Federal Government purchased during the fiscal year ended June 30, 1864, 188,718 horses. Captures reported added 20,388 more, and the number consumed daily was therefore 500 head, without considering those captured and not reported. During eight months of the year 1864 the Cavalry of the Army of the Potomac was remounted twice, nearly 40,000 horses in all being required. During his Shenandoah Valley campaign Sheridan was supplied with fresh horses at the rate of 150 per day. In his report

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for the year 1865 the Quartermaster General of the United States Army stated: "The issue of Cavalry horses to the Army of the Shenandoah actively engaged under Maj. Gen. Sheridan have been at the rate of three remounts per annum. The service of a Cavalry horse under an enterprising commander has therefore averaged only four months."

If the 50,000 horses now required by the mounted service of the Regular Cavalry and Militia (excluding those for wagon trains, etc.) were called into active war duty, we could look for a demand of upward of 150,000 horses per annum, basing the estimate on the experience of Gen. Sheridan's army.

The British Army in South Africa 10 years ago consumed enormous numbers of horses, over 100,000 being bought in the United State alone, and, incidentally, it may be remarked that this exportation of horses went a great way toward causing the shortage of horses of the right type for Army purposes which we now observe in the United States and created a situation of which draft-horse breeders were quick to take advantage. It is exceedingly doubtful whether a foreign government could now obtain such a supply in the United States. How, then, could the United States itself mount an army? If with draft horses, or horses of draft breeding, how could it meet a hostile cavalry properly mounted?

THE REMOUNT SYSTEM IN THE UNITED STATES.

The use of remount stations in the United States as depots where young horses are developed and educated for use in the Army has been inaugurated during the last five years. In a lecture before the Army War College in February, 1907,[1] Maj. (now Q. M. Gen.) J. B. Aleshire presented an elaborate plan to improve the conditions under which horses and mules were supplied to the Army, urging the purchase of young horses direct from breeders and developing them at Army stations so that by the time they were mature they would be ready for actual service, undesirable ones would be weeded out, those retained would have been given rational development and handling, and a much longer period of usefulness could therefore be expected from them than from mature horses purchased under contract.

In presenting the report of the Quartermaster General for the fiscal year 1907, Gen. Aleshire brought his remount plan directly to the attention of Congress.[2]

> He urged the establishment of "three or more remount depots, to be properly organized, located, and equipped, and the same number of remount districts. * * * To each of the three or more remount depots would be assigned a remount district, and each depot and its tributary district would be in charge

[1] Army horses, etc., U. S. War Department, Washington, 1908.
[2] Annual Report, Quartermaster General, War Department, 1907.

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of an officer of the Quartermaster's Department, preferably detailed from the cavalry or field artillery and especially adapted for this duty. * * * The officer in charge of each remount depot * * * would personally superintend the care and handling of the horses under his charge and see to it that the horses were well fed and cared for, gently and kindly handled at all times, and properly exercised and broken.

"When directed by proper authority, he would purchase young horses, to conform to specifications, within the district assigned to his remount depot, to which they would be shipped.

"He would be required to acquaint himself with and keep a record of the number and class of horses, how bred (if possible), by whom owned, where located, and generally complete data of the horse and mule production of his district, and be prepared to direct a purchasing officer or to go himself to the place most suitable for the establishment of subdepots, in case of an emergency, and where the best horses could be found.

"The average life or period of duration of cavalry and artillery horses has heretofore been 6.4 years, and that of the mule 10.6 years.

"In view of the fact that the young horses to be sent to the remount depots will be carefully selected and be purchased for remount purposes before they are worked down, injured, or spoiled by improper breaking, and since the number of remounts to be supplied annually is to be limited, which in time will result in the mount of each organization being composed of horses of ages from 4½ years up, the number of each age being approximately that supplied each year, it is submitted that the average life or period of duration of remounts for cavalry and artillery will be materially increased by this system of purchase and supply, and it is therefore taken at 10 years, barring epidemics, etc."

By the increase in the average life of animals purchased under this plan, the estimate was made that the cost of remounts for the Army could be reduced one-third. It was also suggested that the development of the plan and the experience gained by officers in connection with it would enable the Army better to meet emergencies requiring a large increase in the number of animals required.

Among the advantages of the proposed system were pointed out the following:[1]

The Army will be supplied with young, fresh, sound, and well-broken horses, in every way suitable for the service, and that have not been spoiled or injured while breaking, as is often the case under the present system.

These young horses will be fed grain and receive the best of care a year earlier, and therefore be much stronger and better animals when sent to the troops and batteries at from 4 to 5 years of age than if wintered by farmers or on the ranges and purchased a year later, as at present.

It creates a market for young horses from 3 to 4 years old, and the Quartermaster's Department would have few, if any, competitors; the first cost should therefore be less, and the department as a buyer would be in close touch with the horse raisers and breeders.

The average life or period of duration of the horse will be longer, so that about one-third less number of remounts will be required yearly, with a corresponding reduction in expenditure.

The cost will be one-third less, as the department will be able to select desirable young horses from all over the United States, whereas at present

[1] Ibid.

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western horses, though in many cases well bred, are not desirable, as they are not broken, gentled, or handled until a week or two before they are offered for sale as Cavalry or Artillery horses, and when purchased many of them are never serviceable. This system will afford time and means to properly handle and break these young horses and to accustom them to man from an earlier age.

An opportunity will be afforded for a close and careful observance of all horses for several months before issued, and such as are found undesirable or not suited for the service can be disposed of from the depot. The Government would therefore save the freight to posts on such horses, and, since they are young, they should sell at the depot for nearly their first cost.

Horses will be uniform as to conformation, action, etc., and the special type desired will be standardized and understood by breeders and farmers.

Horses can be shipped in first-class condition in every respect and in cars that are sanitary; there should therefore be practically no sickness on arrival at posts.

Requisitions can be filled promptly without waiting for advertising and purchase, as at present, and horses of desired color can be sent to a particular troop or battery at no additional expense.

The Quartermaster General suggested the use of abandoned military posts, such as Fort Reno, where buildings were already available and the plan could be put into effect without extra expense. His recommendations were approved by Congress in the Army appropriation act for the fiscal year 1909, and under General Order No. 59, War Department, 1908, the military post of Fort Reno, Okla., was designated as a general supply depot of the Quartermaster's Department, and would thereafter be known as the Fort Reno Remount Depot. A year later General Order No. 80, War Department, 1909, similarly designated Fort Keogh, Mont., as a remount depot. Issues from the Fort Reno depot were commenced during the fiscal year 1909.[1]

In the spring of 1910 purchases of horses were begun in Virginia and Kentucky, and an officer was detailed for the purpose, with station at Front Royal, Va. The horses first purchased in this district were sent to Fort Reno, but in the Army appropriation act for the fiscal year 1912 an item of $200,000 was included for the purchase of land in Virginia for a remount station, where the horses in that district will be developed in future. The new station is located at Front Royal, on the Blue Ridge.

The following statement, furnished by the office of the Quartermaster General, United States Army, shows that the horses purchased under the remount system are costing the Government much less than those purchased under contract:

Fiscal year 1909.

Cavalry horses, average contract price	$160.06
Artillery horses, average contract price	191.12
Young horses for remount depots	146.28

[1] Annual Report, Quartermaster General, War Department, 1909.

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Fiscal year 1910.

Cavalry horses, average contract price	$173.24
Artillery horses, average contract price	205.25
Young horses for remount depots	127.45

Fiscal year 1911.

Cavalry horses, average contract price	$166.76
Artillery horses, average contract price	212.17
Young horses for remount depots	134.07

The age at which young horses are being purchased is becoming less than was originally suggested, quite a large number of 2-year-olds being selected. Mainly, however, these horses are 3 years old, and few, if any, 4-year-olds are bought.

It is expected that eventually all the horses supplied to the Army will be purchased in this way. In fact, the contract system of buying is even now more or less of an exception, the only recent contracts of importance being during the maneuvers in Texas.

The remount plan in itself has everything in its favor and practically nothing against it. The farmer gets a fair price for his colt rather than a poor price on which a middleman formerly had to figure a profit. The Army now has a range of selection which it never had before; it is not now necessary to "take the cats and dogs" or go without horses; and, above all, the writer ventures the assertion that the remount system has had a decided influence on the horsemanship of mounted officers in the Army, for the simple reason that much more interest will be taken in a better horse concerning whose breeding something is known and whose history is known practically from birth.

WEAK POINTS OF THE REMOUNT SYSTEM.

The remount system has two weak points, which are not, however, inherent in the plan itself, but obtain in the conditions surrounding the horse-breeding industry, due to the peculiar developments of horse breeding in the United States during the last 40 years and the average man's lack of ability as a horse breeder.

The scarcity of suitable horses.—The scarcity of horses of the light type, from which the Army supply must come, has been fully set forth in the foregoing pages. Under the present peace footing the Army can and will obtain a fairly satisfactory supply of horses by the remount system; it can keep a staff of officers in the field looking for horses just as a large city firm of horse dealers keeps its buyers traveling, although at greater expense, because the Army is looking for only a few classes of horses, while the city firm handles all kinds; the numbers the dealer purchases are therefore much larger and the average expense to be charged against each horse is correspondingly less. It is not claimed that the Army can not now find the mounts needed under the present peace footing by means of the remount

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plan of purchase and development, but it is claimed that there is no reserve; that a demand for a considerable increase in the number of horses used annually by the Army—such, for instance, as would be necessary in case of war—could not be supplied in a satisfactory manner from the supply of horses now in the United States, large in numbers as that supply is known to be; and it is also claimed that in the comparatively near future the developments of the horse industry will be such that unless steps are taken to stimulate a waning industry by Government encouragement the Army will be able to obtain its necessary horses only at greatly increased expense. The light type of horse will become more and more difficult to obtain, and the Army horse scarcer and scarcer. The Army can not be mounted on draft horses, and our farmers are now raising nearly two draft colts to one light colt.

People not closely familiar with the agricultural development of the country are wont to read complacently the magazine articles in which the wonderful development of the West is set forth in glowing terms. They are told that the settler is slowly but surely encroaching on the ranchman, that the saddle and lariat are giving way to the plow and harrow, and homes are building where cattle and horses roamed before. They do not realize that this western country was once the range of thousands of horses which were useful for Army purposes, and that the inevitable result of the new development in the agriculture of that section is to make horses and cattle scarce. They read of the wonderful agriculture of the corn belt, the production of cereals, the massive machinery, etc., not realizing that the farmer is compelled by these conditions to get a maximum amount of horsepower out of each work animal, to have his horses as large of frame and as small in number as possible.

The tide in favor of heavy draft animals on farms where topographical and climatic conditions favor their use will not, and doubtless can not, be turned. There is no reason why it should be turned. The Army must look elsewhere for its supply, and it is only plain business foresight and judgment for the Government to encourage the breeding of a type of horse, in suitable localities, that will be useful not only for the Army but satisfactory to the farmer as well.

Lack of system in breeding methods.—The remount system as at present established is also incomplete in that it provides no means whereby the breeding of horses of the proper type can be encouraged. Everyone knows the innate fascination for the average mare owner to see how many different experiments he may make in mating. He may own a good, useful type of mare, and he will breed to Standard-bred, draft, pony, saddle, and Thoroughbred stallions, hit or miss, and not hesitate to try a jack to see what that will bring. The Army buyers will doubtless do all in their power to advise mare owners to breed, but their advice can only carry such weight as more or

less acquaintance between the owner and the officer may effect. The only way to get anywhere in breeding is to be systematic, to adopt a policy and stick to it. The man who is always talking about crossing is usually the man who has more mongrels than his neighbors. The man who can cross successfully is the able breeder who needs no advice or assistance and who breeds horses far above the Army standard.

The experiment made in Virginia in the spring of 1911[1] shows that farmers will welcome an invitation to enter into cooperation with the Government in the production of horses for the Army. It appeals both to patriotism and the pocketbook. If such a plan is put into effect, the Government will know where horses are, it will know what they are, and it will be able to find and obtain them at a minimum cost.

A PLAN TO ENCOURAGE THE BREEDING OF HORSES FOR THE ARMY.

With the establishment of direct purchases from farmers in connection with the remount system, Army officers almost immediately found that it was not an easy task to find the required number of suitable horses and the matter was soon given consideration by the War Department, with the result that the Secretary of War laid the matter before the Secretary of Agriculture in 1910 and representatives of the two departments were designated to devise means to remedy the situation. The result was a plan for the encouragement of breeding horses for the Army. This plan appears in full in the Report of the Chief of the Bureau of Animal Industry for the fiscal year 1910.[2] In brief, the plan was drawn so as to provide in time for a sufficient number of remounts annually for the mounted service of the Army on the present peace footing. The country is to be divided into four breeding districts and 100 stallions purchased to stand for service free of charge for approved sound mares, the mare owner to give in return an option on the resulting foal during the year it is 3 years of age. The localities suggested for breeding districts are those where conditions are especially suited for horse raising, where the prevailing type of mares is most likely to approach that desired for the Army, where a light type of horse will always in the long run be the most profitable to the farmer and draft horses least likely to obtain a firm foothold, and where mares are sufficiently numerous to give the stallions maximum service.

Fifty Thoroughbred stallions, 25 Standardbreds, 15 Saddle stallions, and 10 Morgans are suggested.

ARGUMENTS FOR AND AGAINST THE PLAN.

Two arguments have been advanced against this plan—the first, that it is unnecessary because horses of the desired type are plentiful;

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[1] See p. 122. [2] See pp. 34–46 of this volume.

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the second, that by adding the amount suggested for the breeding appropriation ($250,000 the first year and $100,000 in succeeding years) to the amount now appropriated for the purchase of horses for the Army, and thus adding $50 to $100 to the average price paid for horses, the necessary number could easily be obtained.

The writer believes that the figures shown on page 107 for the relative numbers of purebred draft stallions in various States effectually answer the first argument. It must be again plainly pointed out that there are now probably enough horses annually available for the requirements of the present peace footing of the Army. The country should in wisdom, however, provide for a reasonably sufficient supply in case of war, and it should take steps to check the unquestionable decrease in the breeding of light horses. Cavalry is of the utmost importance in warfare, and we must sooner or later either encourage the breeding of horses for the mounted service of the United States Army or dismount the cavalry.

The second argument voices a popular appeal which carries considerable weight, but it is very doubtful whether it would in any measure bring about the desired result. Let it be repeated that the Army is now paying good prices to farmers for the horses it buys. Officers claim that they are paying somewhat more than farmers have usually received for such horses. One hundred and fifty dollars for an unbroken 3-year-old colt, or $125 for a 2-year-old, are not starvation prices as farmer's colts run. The purchasing officers are buying in the face of the competition of other buyers. For the Government to add gratuitously $50 or $100 to the price now paid would be reckless and wasteful extravagance. This argument has been advanced by persons who do not seem to realize the difference between the direct system of buying young horses for the remount stations and the old system of buying by contract mature horses for direct issue to troops. The former eliminates the middleman's profit and gives the farmer a fair price; the latter gave the farmer a price which was far below what a good mature horse was worth, and the whole system worked against getting good horses. If the contract system only were considered, adding $50 to $100 to a minimum contract price might have some effect, but the contractor would probably be the principal gainer. The price paid by the Army for horses is now governed by supply and demand, just as that of any other commodity.

Again, if a given sum were added to the average purchase price and the country were plunged into war where large numbers of horses were needed, $50 to $100, nor twice those amounts, would not supply the demand unless horses of draft breeding were taken. Witness the New York police department, with a contract price of $372.50 per head, scouring the country for 75 saddle horses per year of certain definite specifications.

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Lastly, the Government would be no further ahead than before by adopting such a policy. The Government would have absolutely nothing to show for the added expenditure. The horses would be no better and would last no longer. The same unsystematic methods now prevailing would still prevail. On the other hand, with the expenditure for breeding recommended by the Agricultural and War Departments, the Government would be able to develop a systematic and economical system of breeding; it would know what was wanted and would get it. It would also insure a reserve supply of horses if needed. It would not be worth while for the Government to pay $50 to $100 per head as a bonus or gratuity to the owners of colts, but it would be well worth that much for the Government to know what it was getting when a colt was purchased as a remount, to know that the horses bought for the Army were bred for that purpose, and that there were others to select from if needed. A further advantage which would accrue to the Government's profit would be that the exact location of available young horses would always be known, and no time would be lost in hunting for them; much of the incidental expense which is now necessary for traveling could therefore be saved.

What to do with horses bred under this plan on which the Government does not exercise its option is not a difficult problem. It is proposed to use only first-class, sound stallions, with good conformation and action. These stallions would be better than the average, and it is reasonable to suppose that their get would be also. Such being the case, those of the get which were not taken by the Government would be suitable for various uses as general-purpose horses, for farm work, saddle, etc. If the breeding plan is once put into complete operation there is no doubt that European buyers would be ready to take whatever they could obtain. It is also reasonable to suppose that on account of the high character of the stallions the percentage of unsound get would be below the average.

The effect which the plan would have on horse breeding in general would be decidedly beneficial. It would in the first place call attention to the advantages of certain localities for horse breeding and the suitability of certain breeds to certain localities (which has been neglected in the United States in all lines of stock breeding), and would therefore encourage specialization in horse breeding. It would give system in breeding where little now exists; and above all, it would direct immediate attention to the objection to the use of an unsound horse for breeding purposes, for no unsound stallion would be used nor an unsound mare bred.

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THE PRESENT HORSE-BREEDING WORK OF THE DEPARTMENT OF AGRICULTURE AND ARMY HORSE BREEDING.

Shortly after the presentation of the army horse-breeding plan to Congress, Mr. August Belmont, of New York, offered the Government the use of two of his best-known Thoroughbred stallions, Henry of Navarre and Octagon, to be used to encourage the breeding of army remounts. These horses stood during the season of 1911 at Front Royal, Va., and were available for public service on the terms outlined in the Government's plan. About 50 mares were bred, and options were taken on the colts at $150 each at 3 years of age. The agreements were so drawn that the Government would waive its option on horses promising to mature over 16 hands. Half-breds over 16 hands in Virginia furnish the most of the high-class hunters from that section, and a concession on that point was deemed desirable.

Mares bred were required to be straight-gaited trotters without faulty conformation, such as curby hocks, and free from the following hereditary unsoundnesses:[1] Bone spavin, ringbone, sidebone, heaves, stringhalt, roaring, periodic ophthalmia, lameness of any kind, and blindness, partial or complete.

The experience of the department in this case has demonstrated that the Army horse-breeding plan is practical. Mare owners willingly enter into the agreement when they realize that it is one of mutual advantage. No difficulty whatever was experienced, and a much larger number of mares would have been bred had the horses reached Virginia somewhat earlier and had Octagon not had a serious attack of distemper shortly after his arrival.

The expenses of this trial have been slight, but such as have been incurred have been paid from the appropriation for cooperative experiments in animal feeding and breeding, in the act of Congress making appropriations for the Department of Agriculture, which provides authority for such experiments. It is really only an experiment, but so far as it has gone it is satisfactory. It should now be followed with a general introduction of the breeding plan.

The work in carriage-horse breeding in cooperation with the Colorado Experiment Station may have some bearing on the work of breeding Army horses, as the stallions bred in that project should make useful sires of artillery remounts; and the Morgan Horse Farm may produce some of the stallions needed for the New England district of the Army horse-breeding project. However, it should be specifically stated that neither project was outlined with the Army demand in view. The Army horse project, if provided for by Congress,

[1] This list was compiled several years ago by the Bureau of Animal Industry for another purpose, after consultation with members of the American Veterinary Medical Association and successful horsemen in various parts of the country. A Morgan stallion loaned by the bureau to the Massachusetts Agricultural College stood during the season of 1911 on similar terms, with satisfactory results.

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will have no effect whatever on the purpose, plan, or methods of either the carriage horse or Morgan breeding projects, but horses bred at those stations may be used incidentally in the Army work.

SUMMARY.

1. All modern countries, except those in America, have found it necessary to encourage the breeding of horses suitable for military purposes.

2. Little or no difficulty was experienced in mounting the armies of the Civil War with suitable horses.

3. The draft-horse industry has been developed in the United States since the Civil War, and in several States there are now more than four times as many purebred draft stallions as purebred Standardbred, Thoroughbred, and coach stallions, notably in Iowa, Minnesota, Nebraska, North Dakota, South Dakota, and Utah. In North Dakota the ratio is nearly 8 to 1.

4. The difficulty and expense of obtaining suitable military horses is illustrated by the mounted police of our cities, whose mounted patrolmen combined would not equal a regiment of cavalry on a war footing. The New York police department buys only about 75 horses annually for its mounted police, and has to pay nearly $400 each for them.

5. The militia requires good mounts for its cavalry and artillery, but must depend on the holdings of livery stables and what can be picked up in other ways. Very little systematic work has been done in breeding horses for the militia.

6. The mounted service of the Army is now being furnished in a satisfactory manner with horses purchased and developed under the remount system.

7. An outbreak of war would necessitate at once more than twice the number of horses now in the Regular Army, and hostilities would probably require complete new issues every four to six months.

8. The remount system is working satisfactorily, but it will never be completely effective until steps are taken to alleviate the present scarcity of horses of the type needed for military purposes and to produce such horses in a systematic manner.

9. The plan devised by the Agricultural and War Departments to encourage the breeding of horses for the Army is necessary, because horses of the proper type are not sufficiently numerous to supply the Army in case of war, and the time may soon come when it will be difficult to supply those needed in peace; it is economical, because the expense of the plan, averaged on the colts purchased, would be met by value received, in the better quality of the colt, the fact that he was bred for the purpose, that the Government would know what it was getting, that the horses needed for the Army would be more readily found, and on account of the beneficial effect on horse raising

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in general. It is practical, as has been shown by the experiment in Virginia during the season of 1911.

10. To add $50 or $100 to the price now paid for remounts would be wasting money. The farmer now receives as good a price for his colts from the Army as anyone else pays. If this plan were pursued, the Government would make no progress whatever toward the solution of the breeding problem, for it could have no influence on the methods used except in an indirect and futile way.

11. The general effects of the plan on horse breeding would be decidedly beneficial. It would tend to specialize horse breeding, it would discourage the breeding of unsound horses, and it would open up the market for horses of the Army type by creating a supply that foreign buyers would soon take to their advantage.

12. The horse-breeding projects of the Department of Agriculture now in progress may lend somewhat to the Army horse project, but they were not designed with that in view, and it would not be proposed to alter their purpose on account of the Army project.

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THE PRINCIPLES OF BREEDING AND THE ORIGIN OF DOMESTICATED BREEDS OF ANIMALS.[1]

By J. Cossar Ewart, M. D., F. R. S.,
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INTRODUCTION.

When and where man first turned his attention to the breeding and rearing of animals it is impossible to say, because we have no means of accurately determining the age of the deposits in which the remains of domestic animals first make their appearance. It is also impossible to say under what conditions animals lived when first tamed. Herodotus tells us that the lake dwellers, who inhabited Lake Prasias about 500 B. C., "fed their horses and other beasts on fish." But while some of the domestic animals in the possession of the pile dwellers of Europe lived under unnatural conditions, the domestic animals belonging to the people who in prehistoric times occupied the more fertile parts of central Asia probably lived under nearly natural conditions.

The most striking fact about the modern breeds of domestic animals is that they, as a rule, consist of strains which often differ in form, color, and disposition. This is probably due to the fact that the stability of a species is disturbed by domestication and because in addition to artificial selection there has been in many cases an almost complete cessation of natural selection. But even in prehistoric times domestic animals varied. That they began to vary very soon after they were first domesticated is clearly shown by recent explorations in central Asia.

Of these recent explorations the one at Anau, in Russian Turkestan, under the direction of Prof. Raphael Pumpelly is the most suggestive because it helps us to realize the conditions that prevailed immediately before and after animals were first domesticated. In the lowest layers of one of the two huge mounds that mark the sites of long-forgotten eastern cities only wild animals were represented, but in later deposits the remains of domestic and wild animals were found side by side. Up to about 10 feet from the foundations of the earliest habitations the bones of a wild sheep, a wild ox, and a wild horse were found, but about the 10-foot level there were in addition

[1] This article was delivered by the author in the form of five lectures at the Graduate School of Agriculture held at Ames, Iowa, during the summer of 1910.

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remains of domesticated sheep, horses, and cattle. At first there was little difference between the bones of the wild and the tame individuals, but the upper layers contained the remains of small cattle and of sheep with horns distinctly smaller and lighter than those of the wild sheep living in the vicinity. Hence in central Asia, as in Europe, we seem to have evidence that domestication has from the first led to variation in the skull, limbs, horns, etc.

It may be safely assumed that in addition to changes in the skeleton, which likely enough escaped the notice of the ancient stock owners, there were changes in conformation, color, coat, and horns, which doubtless attracted quite as much attention in prehistoric times as they do to-day. When it was observed by the settlers of an ancient oasis that the domestic sheep in their horns or limbs differed from the wild sheep on the adjacent mountains, or that the domestic cattle differed from the wild varieties which grazed in the vicinity of the adjacent forest, the more thoughtful inhabitants would wonder how the changes had been brought about, and as likely as not endeavor to account for them. How changes in size, form, color, and disposition of horses, sheep, and cattle were accounted for by the early inhabitants of Turkestan it is impossible to say; but this much is certain, that at a very remote period stock owners believed that some modifications resulted from maternal impressions, that others were due to the females being "infected" by their first mate, or resulted from acquired (noncongenital) characters being transmitted.

EFFECT OF MATERNAL IMPRESSIONS ON OFFSPRING.

As many experienced and successful modern breeders believe that the offspring are liable to be influenced by parental impressions and hold firmly to the doctrine of "infection," and also believe that acquired (noncongenital) characters are transmitted, it will be well, before dealing with the principles of breeding, to refer to some of the beliefs of breeders.

Many of the modifications met with in domestic animals are believed to be due to maternal impressions. Some years ago a physician in an article in the Lancet on maternal impressions said:

> The belief in the power of maternal impressions to cause deformities in the fetus in utero was pretty general in the medical profession up to the beginning of the last century, and even at the present day there are not a few medical men who are unable, in the face of many well-authenticated cases, to refuse to believe that maternal impressions and fetal deformities do sometimes stand in the relation of "cause and effect," even though it be impossible to say definitely what the modus operandi is.[1]

About 10 years ago Dr. A. Russel Wallace sent me a photograph of a boy born with one of the arms amputated below the elbow, a deform-

[1] Lancet. London, Nov. 3, 1900.

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ity which he thought might be due to parental impressions. In many of the cases recorded there is the loss of several fingers or of the entire hand. One can understand how fingers or an arm might be amputated by the umbilical cord or by a clot interfering with the circulation, but it is difficult to conceive how maternal impressions can reach and materially alter the structure of the fetus. When experimenting with rabbits a litter made its appearance, including three individuals with shriveled-up tails, which eventually disappeared. I accounted for the abnormal tails not by the maternal-impression doctrine, but by assuming that the circulation in the caudal vessels had been interfered with. As deformities often occur when there is no history of maternal impressions, and as there is no means known by which impressions can be conveyed from the mother to the fetus, breeders need not anticipate that owing to the influence of maternal impressions a certain percentage of their young stock will be annually born with imperfect limbs or other deformities.

But while breeders may admit that maternal impressions are not likely to lead to deformities, they often believe that the color of birds and mammals is liable to be influenced by the surroundings. The patriarch Jacob, by placing peeled wands before the fulsome ewes, indicated that he believed the color of the offspring depended to a certain extent on the color of the objects seen by the ewes while conceiving. There are still breeders who follow the example of Jacob. A writer in Bibby's Quarterly some years ago pointed out that the offspring of fowls are liable to resemble in color the hens seen by their parents in a neighboring run, and Prof. Wallace, in his work on Farm Live Stock of Great Britain[1] (1907), says: "The color of any object at which an animal looks while conceiving or during the early stages of pregnancy may sometimes govern the color of the young." In support of this view it is mentioned that a breeder "succeeded in preventing his black polled Angus cows from breeding red or broken calves by putting up a high black fence round the paddock in which he mated them as they came in season, thus preventing their seeing the parti-colored cattle of his neighbors."

Reference is also made to "one of the most remarkable cases of the influence of imagination on the color of cattle." In this case Aberdeen-Angus cows which never saw cattle "of broken colors" had pure black calves, while cows pastured in a field from which Ayrshire cattle were visible produced several badly marked calves annually. It is possible that the black Angus cows in some incomprehensible way were so influenced by the gaudily colored Ayrshires in the adjoining field that they produced broken-colored calves, but I think there is another and better explanation. The Angus polled

[1] Live Stock of Great Britain, 1907, p. 12.

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breed is a blend of several varieties which varied in color from black through brown, red, and yellow-dun to white. Evidence of this we have from a Banffshire writer, who tells us that early in the nineteenth century, though the favorite color of Aberdeen-Angus cattle was black, the brindles were esteemed, the dun not disliked, but the white or streaked were little sought after. Until it is proved that the broken colors which now and again appear in the polled Angus breed are not due to reversion, it seems unnecessary to believe that they are due to maternal impressions. If I were a breeder of Aberdeen-Angus cattle I would not erect a high black fence as an insurance against broken colors.

TELEGONY.

Physiologists and breeders have long believed that the first sire not only contributes traits to his own offspring, but also to some of the subsequent offspring by other, it may be, very different sires. They, to use the words of Agassiz, hold "that the act of fecundation is not an act which is limited in its effect, but that it is an act which affects the whole system, the sexual system especially; and in the sexual system the ovary to be impregnated hereafter is so modified by the first act that later impregnations do not efface that first impression." Some others agree with Carpenter that when "infection" occurs "the blood of the female has imbibed from that of the fetus through the placental circulation some of the attributes which the latter has derived from its male parent, and that the female may communicate these with those proper to herself to the subsequent offspring of a different male parentage."

Others agree with Herbert Spencer that germ plasm passes from the developing embryo into the tissues of the parent to be afterwards incorporated in at least some of the germ cells as they reach maturity, while others hold with Weismann that if there is such a thing as telegony some of the unused germ plasm of the first mate penetrates the immature ova and eventually takes part in controlling the development of offspring by subsequent mates.

Those who believe that the infection is brought about by protoplasmic masses finding their way from the fetal membranes into the circulation of the mother say that telegony occurs only in mammals, but those who believe that infection is due to some of the unused germ cells of the first sire penetrating the immature ova admit that telegony may occur in birds as well as in mammals.

At the end of the seventeenth century evidence in support of infection was generally obtained from mule-breeding establishments, but later believers in the infection doctrine were indebted for their most striking cases to dog breeders. Though as a rule mares and bitches which had produced offspring to a sire belonging to an alien

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race or breed were regarded as "corrupted," mares which had been used for mule breeding were sometimes sought after, because it was believed they yielded more vigorous offspring to sires of their own kind. This may be gathered from a statement made by Beecher, a physiologist who lived at the beginning of the eighteenth century. Writing on infection, he said:

> When a mare has had a mule by an ass and afterwards a foal by a horse there are evident marks in the foal of the mother having retained some ideas of her former paramour, the ass, from which such horses are commended on account of their tolerance and other similar qualities.

Though Herbert Spencer and other philosophers believed in infection, and Darwin believed that the characters of the subsequent offspring were affected by the first sire, telegony has never been regarded as an important factor in the evolution of species. The only thing believers in the infection doctrine insisted on was that an infected female could not be trusted to produce pure offspring to a member of her own breed. It hence follows that infection may be regarded as of minor importance except in so far as it affects breeders.

LORD MORTON'S EXPERIMENTS.

Believers in telegony find the best support for their doctrine in experiments initiated about the beginning of the nineteenth century by Lord Morton with a view to domesticating the quagga. Lord Morton secured a male quagga, but having failed to obtain a female the domestication experiments were abandoned. Had a female been available the quagga, instead of being extinct, might have been added to our list of domestic animals. In the absence of a female quagga, Lord Morton mated his quagga stallion with "a young chestnut mare of seven-eighths Arabian blood" which had never been bred from. The result was a female hybrid "bearing both in her form and in her color very decided indications of her mixed origin." The chestnut seven-eighths Arab mare, having passed into the hands of Sir Gore Ouseley, produced to a "very fine black Arabian stallion" a filly foal in 1818 and a colt foal in 1819. On August 11, 1820, Lord Morton examined the filly and the colt, and on the day following wrote an account of them to the president of the Royal Society. In this letter Lord Morton says:

> The 2-year-old filly and yearling colt have the character of the Arabian breed as decidedly as can be expected where fifteen-sixteenths of the blood are Arabian; they are fine specimens of that breed, but both in their color and in the hair of their manes they have a striking resemblance to the quagga. Their color is very marked, more or less like the quagga in a darker tint. Both are distinguished by the dark line along the ridge of the back, the dark stripes across the forehand, and the dark bars across the back part of the legs. The stripes across the forehand of the colt are confined to the withers and to the

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part of the neck next to them. Those on the filly cover nearly the whole of the neck and the back as far as the flanks. The color of her coat on the neck adjoining to the mane is pale and approaching to dun, rendering the stripes more conspicuous than those on the colt. The same pale tint appears in a less degree on the rump, and in this circumstance of the dun tint also she resembles the quagga.

Both their manes are black; that of the filly is short, stiff, and stands upright, and Sir Gore Ouseley's stud groom alleged that it never was otherwise. That of the colt is long, but so stiff as to arch upward and to hang clear of the sides of the neck, in which circumstance it resembles that of the hybrid. This is the more remarkable, as the manes of the Arabian breed hang lank, and closer to the neck than those of most others. The bars across the legs, both of the hybrid and of the colt and filly, are more strongly defined and darker than those on the legs of the quagga, which are very slightly marked; and though the hybrid has several quagga marks, which the colt and filly have not, yet the most striking—namely, the stripes on the forehand—are fewer and less apparent than those on the colt and filly.

The points of special interest in this letter are:

1. The bars across the legs of the hybrid, the colt, and the filly were more strongly defined than the stripes on the legs of the quagga.

2. The stripes on the forehand of the colt and filly were more numerous and more distinct than in the hybrid.

3. The mane of the yearling colt was long, but so stiff that it arched upward so as to hang clear of the neck.

4. The mane of the 2-year-old filly was short, stiff, and upright. According to Sir Gore Ouseley's stud groom the mane had been stiff and upright from the first.

That the bars across the legs of the hybrid, colt, and filly were more strongly defined and darker than in the quagga is borne out by drawings by Agasse in the Museum of the Royal College of Surgeons, London.

As in Arabs and Arab-pony crosses the legs are sometimes distinctly striped; the presence of bars on the legs of the colt and filly can not be regarded as affording evidence of infection. The same may be said of the indistinct markings across the neck, withers, and back of the filly, for in oriental ponies stripes sometimes occur across the back, and there may even be spots, as in zebra hybrids, over the hind quarters.

As the chestnut dam of the filly was purchased in India, it may very well have been a descendant of the striped Kathiawar race. Further, as the sire of the filly was black, it is extremely unlikely that he belonged to one of "the five" recognized pure Arab strains. It is admitted that the chestnut mare was not a pure Arab, and we know that even high-caste Arabs are a blend of several types. As in the quagga hybrid there were only three stripes across the withers, it seems to me extremely probable that the numerous faint, ill-defined stripes on the neck and back of the filly are best accounted for by

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assuming that the filly had, in its coat, reverted toward a remote striped ancestor, from which Kathiawar and other eastern striped breeds had in part descended.

But while in the stripes we have insufficient evidence of infection, we seem to have the evidence required in the short, stiff, upright mane of the filly. Lord Morton examined the filly in August, 1820. In the following summer the drawings of the colt and filly in the Museum of the Royal College of Surgeons were made by Agasse, one of the most reliable animal painters of the first half of the nineteenth century. Agasse represented the mane of the filly as lying to one side of the neck.

If up to August, 1820, the mane was naturally short, stiff, and upright, it is difficult to understand why it was lying to one side when Agasse made his sketches in the following summer. In the Equidæ there is always an intimate relation between the mane and the tail. When the upper part of the dock carries long hairs, the hairs of the mane are long; when it carries short hairs, many of which are annually shed, the mane consists of short hairs. Judging by the condition of the tail in Agasse's drawing, the mane of the filly should be long and cling to the neck.

From a study of Arab crosses I should not be surprised to find in an Arab characterized by a prominent forehead, high withers, and a high-set-on tail a short mane which arched to one side of the neck, but a mane of this kind would be accompanied by a somewhat mule-like tail. Usually the mane falls to one or both sides of the neck when the foal is about 5 months old. It is conceivable that in the Gore Ouseley filly the mane retained the upright position an unusually long time, but it is also possible that notwithstanding the statement of the stud groom the mane of the filly had been hogged. If removed about the middle of February it would be about 6 inches long and still upright on the occasion of Lord Morton's visit on the 11th of August.

Though Darwin came to the conclusion that "there can be no doubt that the quagga affected the character of the offspring subsequently got by the black Arabian horse," a critical consideration of the Morton-Ouseley experiment in the light of recent knowledge indicates that the evidence in support of the chestnut mare endowing her offspring by the black Arabian with some of the characteristics of her first mate, the quagga, rests on a very slender basis.

THE AUTHOR'S EXPERIMENTS.

Seeing that physiologists as well as breeders 20 years ago believed that infection was common and that Weismann admitted that the belief in telegony might be justifiable and founded on fact and indicated that he would accept a case like that of Lord Morton's mare as

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satisfactory evidence if it were quite beyond doubt, I decided in 1895 to repeat as accurately as possible the Morton-Ouseley experiment on a fairly large scale.

In course of time a stud was formed, including over 50 mares of various races and breeds, a Burchell zebra stallion, Matopo, and two mares of the Chapman variety. One out of 4 chestnut mares, 2 out of 6 black mares, 2 out of 5 skewbald mares, 14 out of 21 bay mares, and 1 out of 17 mares of dun-gray, roan, and other colors were eventually successfully mated with the zebra stallion, but only 13 of the 20 mares served proved fertile. The 13 mares produced from first to last 16 hybrids by the zebra stallion and 22 foals by Arab, Thoroughbred, Highland, and other stallions. Some of the mares which failed to breed with the zebra were used for control experiments.

The first hybrid was born August 12, 1896, the dam being Mulatto, a black Highland pony lent by Lord Arthur Cecil.

In 1897 Mulatto had a foal to Benazrek, a gray Arab stallion. As this subsequent foal of Mulatto was indistinctly striped, I was at first inclined to believe she had been infected by her first sire, the zebra Matopo; but when more richly striped purebred foals were obtained later by Benazrek out of Highland mares which had never even seen a zebra, it became evident that Mulatto afforded no evidence in support of the infection doctrine.

Lord Morton's quagga counted for so little in the hybrid out of the chestnut Arab mare that its right to be regarded as a hybrid has been questioned. Matopo, however, proved so impressive that all his hybrid offspring plainly indicated their descent from a richly striped zebra.

On the other hand, the subsequent foals (by Arab and other stallions out of the mares which proved fertile with Matopo) differed so profoundly from hybrids (even when, as was sometimes the case, they had bars on the legs and faint stripes across the withers) that they afforded no evidence that the first male influences "the progeny subsequently borne by the mother to other males."

OTHER EXPERIMENTS AND VIEWS ON THE "INFECTION" THEORY.

While I was experimenting in Scotland with a Burchell zebra of the Chapman variety Baron de Parana was using a true Burchell zebra for breeding hybrids in Brazil. The Brazil hybrids were as richly striped as the hybrids bred in Scotland. Nevertheless the purebred foals out of mares used in the Brazil experiments neither recalled the previous zebra mate nor in any way resembled zebra hybrids. Baron de Parana, in addition to confirming the results obtained with zebras in Scotland, acquired valuable information from American mule-breeding establishments.

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FIG. 1.—MALE QUAGGA USED IN LORD MORTON'S EXPERIMENTS.

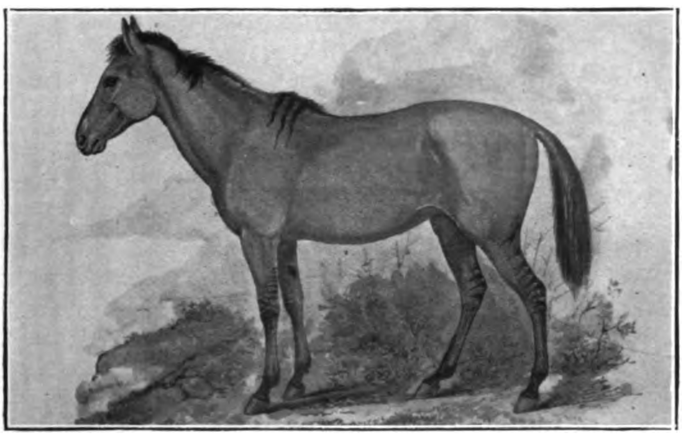

FIG. 2.—HYBRID FROM LORD MORTON'S QUAGGA AND A CHESTNUT ARAB MARE.

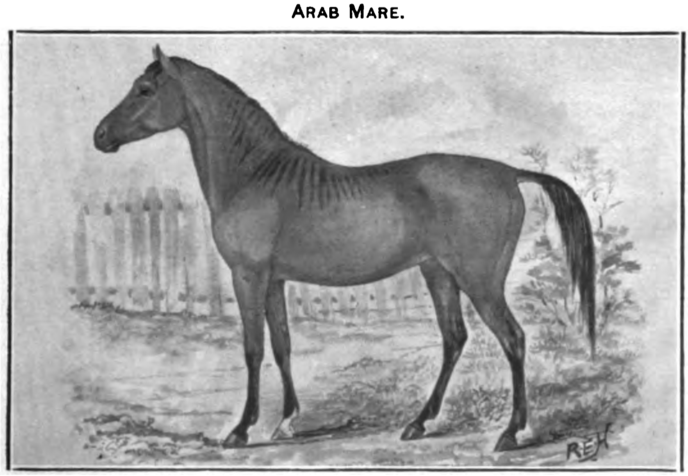

FIG. 3.—FILLY OUT OF THE CHESTNUT ARAB MARE BY A BLACK ARAB STALLION.

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FIG. 1.—BLACK HIGHLAND PONY MULATTO AND HER HYBRID ROMULUS BY THE BURCHELL ZEBRA MATOPO.

FIG. 2.—SKEWBALD ICELAND PONY, HER FILLY CIRCUS GIRL, AND SIR JOHN.

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Mr. Darwin, in discussing infection, says:

It is worthy of note that farmers in south Brazil (as I hear from Fritz Muller) and at the Cape of Good Hope (as I have heard from two trustworthy correspondents) are convinced that mares which have once borne mules when subsequently put to horses are extremely liable to produce colts striped like a mule.

A very different report comes from Baron de Parana, who writes:

I have many relatives and friends who have large establishments for the rearing of mules where they obtain 400 to 1,000 mules in a year. In all these establishments, after two or three crossings of the mare and ass, the breeders cause the mare to be put to a horse because they believe that unless the mares are changed after producing three mules they become sterile. In all these establishments a purebred foal has never been produced resembling either an ass or a mule.

Inquiries made in the West Indies and in Mexico likewise afforded no support to the view that mares are liable to be infected by a male ass or that a she ass is ever infected by a horse.[1]

In addition to making experiments with zebras and horses and with asses and horses I have experimented with horses belonging to different breeds and to different strains of the same breed. I was led to do this because of the belief that Thoroughbred mares are liable to be infected by Shire, Cleveland Bay, Hackney, and other sires and also by Thoroughbred sires belonging to different strains or families and because it is said a coarse Shire mare if first mated to a Thoroughbred horse will subsequently produce improved offspring to a horse of her own type. We have evidence of the existence of these views in an article on some problems of stockbreeding published in 1895 in the North British Agriculturist.[2] In this article it is stated that in racing studs small, weedy, but highly bred mares which might otherwise produce underbred stock, are put to a big coaching or hunting sire and then to a crack Thoroughbred in order that the purebred offspring might gain size and substance from the previous mate through their half brothers.

Further evidence of the belief in infection is seen in statements to the effect that several foals got by Actaeon (for some time a member of the royal stud at Hampton Court) presented unequivocal marks of Colonel, the former mate of their respective dams, and that mares mated with the bald-faced chestnut horse, Blair-Atholl, subsequently produced Blair-Atholl-like foals to sires of a very different type. It was also asserted that mares were infected by Camel, Hermit, and many other Thoroughbreds.

By means of experiments and by investigating so-called cases of infection in Thoroughbred and other studs I arrived at the conclusion

[1] There is, for example, no evidence that Sweepstakes, the dam of Star Pointer and other great pacers, was depreciated by first producing a couple of mules.

[2] Finlay Dun. North British Agriculturist. Jan. 2, 1895.

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that mares are neither liable to be infected by a sire belonging to a different breed nor by a sire belonging to a different type of the same breed. The peculiar marks, gait, etc., supposed to have been inherited from the previous sire could generally be accounted for by reversion to a not very remote ancestor.

From the General Stud Book one ascertains that brothers and sisters have frequently been interbred. When a brother and sister are the offspring of parents belonging to different types they are in a Mendelian sense hybrids. A certain number of the offspring of such hybrids revert, and thus lead the breeder to assume that the dam has been infected. But while some of the reversions, supposed to be due to infection, can be explained by Mendel's law, there are others not so easily accounted for. Reference has already been made to the belief in Brazil that unless mares which have reared two or three mules are put to a horse they are liable to become sterile. The belief that the energies of a mare are often severely taxed by bringing forth and rearing a mule is supported by my telegony experiments. Moreover, the view that hybrids and crosses exhaust the dam more than purebred offspring is held by breeders of sheep as well as by breeders of mules. It is said, for instance, that Cheviot ewes after having lambs to Border-Leicester rams are "more difficult to feed, more broken down, and hence less valuable than after having lambs to rams of their own breed."

Recent inquiries seem to indicate that the growth and maturation of the germ cells in the ovaries vary with the condition of the individual in which they are lodged. For example, when 100 ewes are well fed during and for some weeks before tupping time, 200 lambs may be expected—that is, about 50 more than would arrive under ordinary conditions. On the other hand, if, during gestation, sheep are underfed, the germ cells may suffer from malnutrition, with the result that in the following autumn there is a scarcity of ripe follicles and the relatively small number of offspring produced may fall considerably below the average standard of the herd to which they belong, and in some cases there may even be reversion to ancestral types. Hence, when considering peculiarities in purebred offspring coming after crosses or hybrids, one should bear in mind that individuals developed from insufficiently nourished ova may in form or color resemble remote ancestors.

That the germ cells may be influenced in cows as in sheep, used for breeding crosses, is suggested by the following case: In 1902, two pure Ayrshire heifers were mated with a Shorthorn bull. The result was two white calves. In 1903 the same two Ayrshire cows were put to an Ayrshire bull, but instead of producing calves of the usual Ayrshire form and color they had strawberry-roan calves, which have grown into cows with the face, hind quarters, and hips

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so closely resembling Shorthorns that they might readily pass as Shorthorn crosses. Some would doubtless account for the 1904 calves acquiring Shorthorn characteristics by saying their dams had been infected by their previous Shorthorn mate. There is, however, a simpler explanation, namely, that so much nourishment was required by the 1903 crossbred calves during development that the next crop of ova were insufficiently nourished, the result being that the 1904 calves reverted toward ancestors which happened in face, hind quarters, and hips to resemble Ayrshire-Shorthorn crosses. Had the 1904 (the "subsequent") calves been white like the 1903 Ayrshire-Shorthorn crosses, the evidence of infection would have been considerable, but as the 1904 calves were of a strawberry-roan color it seems to me that the evidence must be regarded as supporting reversion. This view is strengthened by the fact that purebred Ayrshires sometimes in face, hind quarters, and hips suggest Shorthorns.

In addition to experimenting with the Equidæ, numerous experiments were made with sheep, goats, dogs, cats, rabbits, fowls, pheasants, ducks, and pigeons, without obtaining any valid evidence of the infection doctrine.

In 1893 Romanes started discussions on telegony in the principal breeders' and fanciers' journals in England and America and entered into private correspondence with contributors of the largest experience and with professional and amateur breeders. As a result of the discussions and correspondence and of experiments designed to yield positive results, Romanes came to the conclusion that infection is of much less frequent occurrence than is generally supposed—that instead of being common it occurs only in 1 or 2 per cent of cases. Sir Everett Millais, a great authority on dog breeding, after making over 50 experiments with birds and mammals, came to a similar conclusion. Millais heard of numerous so-called cases of infection from America and the Continent of Europe, but he stated that not a single case would "bear a critical inspection for a moment."

A REMARKABLE CASE OF REVERSION IN DOG BREEDING.

As a result of the experiments made during the latter part of the nineteenth century a number of breeders not only lost faith in the infection doctrine, but actually submitted evidence in support of the view that the germ cells are neither infected by unused germ cells of the first sire nor by protoplasmic masses from the fetus reaching the ova through the blood of the mother. On the other hand I am assured that in both the Old World and the New, even breeders who admit that the evidence in support of telegony is far from convincing,

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as a rule welcome any fresh cases which seem to support the infection doctrine. This view is supported by the following extract from the letter of an experienced and extremely well-informed breeder:

> I shall take telegony first, as it is and has always been my favorite subject. Do breeders as a rule believe in it? Well, I am afraid they do. I say afraid, as the big majority of breeders do not do their own thinking, and at any rate very few do so to the extent they ought to. To most I fear telegony is a fine-sounding word, its borders are wide and its depths deep, and because of this it has been accepted when on the same grounds a more innocent-looking problem would have been disbelieved. Personally I have proved it to be a fallacy with a fine name. * * * Ninety-eight breeders out of a hundred believe in it; the ninety-ninth pretends he doesn't, but in reality does; the hundredth is told to prove there is nothing in telegony, although the onus of proof lies with the 98. I have bred prize dogs, cats, cavies, mice, pigeons, and poultry for 20 years; kept pedigrees most carefully, even to color, characteristics, and idiosyncrasies. I have experimented liberally and scores of times have had results which a less careful student would have written down as typical examples of telegony. But the results were invariably a complete denial of telegony; on the other hand they affirmed unbelievable power of reversion. Many of my friends knew of my experiments and they liked nothing better than to swamp my belief in their so-called proofs. One morning a man who had tabooed telegony—or pretended to—wrote saying he had undoubted proof of the truth of telegony. The proof was a litter of puppies from a tan Dachshund bitch and a tan dog (both parents had long pedigrees of tan or black-and-tan ancestors, as most, indeed all, Dachshunds have). Those puppies had pure-white bodies with tan cheeks and ears. Now, the dam had made a mesalliance in her first "heat" with a white Fox Terrier with tan cheeks and ears. Truly, victory seemed with the enemy. I said to my friend that although the puppies were white and fawn they were in make and character pure Dachshunds and that the terrier would have had more effect than merely on the color of the puppies. As that was not satisfying to my friend I set about the solution. The dam's pedigree after the sixth generation was "wrapt in mystery," and it was there I sought the color cause. After some difficulty I traced the last-mentioned ancestor's owner and discovered her in a well-known lady breeder of years ago whose hobby was white Dachshunds with tan cheeks and ears, a variety she exhibited occasionally and which she had originally brought from Germany. So there again it was reversion and not telegony.

When the owner of the tan Dachshunds was presented with a litter of white puppies with fawn cheeks and ears after a litter by a white Fox Terrier with tan cheeks and ears, it was not surprising he believed that a genuine instance of telegony had at last arrived. It is, however, remarkable that it was possible to show that the advent of the white Dachshunds was undoubtedly due to reversion. Seeing that the purebred litter of white Dachshunds followed the crossbred litter by the Fox Terrier, it is conceivable that (as seems to be the case in mares and sheep used to breed crosses) the ova from which the purebred white Dachshunds were developed had suffered from innutrition, or from some subtle change, which resulted in reversion to fairly remote ancestors.

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ALLEGED INFECTION OF THE MALE.

As it happens, there are breeders who, though believing that the female is not liable to be infected by the male, are convinced that the male is sometimes infected by the female. Recently a breeder refused to allow his Jersey bull to serve a Shetland cow I was experimenting with on the ground that the bull might subsequently introduce the characteristics of the old Shetland race into his Jersey herd.

When it was first suggested that the male might be the means of transferring traits from one race or breed to another it is impossible to say. By way of proving that the male may be influenced by the female it has often been stated that a bull which was put to a wild cow at Chillingham produced, when afterwards used with Shorthorns, offspring having the characteristics of British "wild" cattle.

It is not related how the male conveys the characters of one race or breed to another; it is inconceivable that the immature germ cells of the male can be infected by his mate, and it has not been suggested that they are modified by mental impressions. As, however, experiments afford no support to this superstition, there is no need to discuss how a male may be so influenced that he is able to impart to the members of his own race the characteristics of a different (it may be remotely related) race.

SATURATION.

It has often been asserted that each successive child more closely favors the father, and that the mother with each child she bears more closely resembles her husband in appearance and disposition. In support of this view it is said that the children of a white man and a negro woman successively exhibited more and more the European features and complexion.

In the "Encyclopædia of the Stable," published this year (1910), it is stated that many breeders believe that a mare which is repeatedly served by the same horse and breeds a foal to him each time is likely to produce offspring more and more like their sire every year. The belief that the dam more and more resembles the sire to which she bears offspring is now known as the saturation theory. If there is such a thing as saturation, it interests breeders not because the dam acquires the traits of the sire, but because the offspring progressively become more and more like the sire.

Some years ago Bruce Lowe directed the attention of breeders to the saturation doctrine. He pointed out that "with each mating and bearing the dam absorbs some of the nature or actual circulation of the yet unborn foal until she eventually becomes saturated with the sire's nature or blood, as the case may be." Bruce Lowe believed that certain breeding characters are for several generations always

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transmitted by the dam, hence the importance of the dam being saturated by the "nature or blood" of a good sire.

It is doubtless true that in some families the younger children more closely resemble the father than the elder children, but it is also true that in other families the older children take after the father while the younger children resemble the mother.

Experiments with pigeons and rabbits indicate that whether the offspring take after the sire or the dam depends in some cases on the age and vigor of the parents. A male wild blue-rock pigeon mated when barely mature with a vigorous white fantail hen produced, to start with, a pure white bird in form resembling a fantail but decidedly deficient in vigor. When the blue rock was somewhat older his offspring with the white fantail were blue and in the tail and other respects more closely resembled their sire. Similar results were obtained with a young male blue rock and a black barb. When barely mature females were mated with mature males, the young first hatched resembled the sire; the subsequent young were sometimes intermediate, sometimes they closely resembled the dam.

That in supposed cases of saturation the vigor as well as the age should be taken into consideration is suggested by experiments with Indian blue-rock pigeons. A mature male Indian blue rock soon after its arrival in England was mated with a half-bred turbit with reddish wings and shoulders, but otherwise white. The hybrid obtained was of a reddish color and in form resembled the half-bred turbit. Unable to account for the mature Indian blue rock counting for so little in the offspring, I had the blood examined, with the result that the corpuscles were found to be infected by the parasite known as *Halteridium*. When after a lapse of some months the parasites disappeared from the blood and the vigor was restored the Indian blue rock was again mated with the half-bred turbit, with the result that a pair of birds were obtained presenting all the characteristics of the Indian variety of the wild blue-rock pigeon. It may be remarked that the pigeon experiments afford no evidence in support of the view held by some breeders that the male is mainly responsible for the external structure, outward characteristics, configuration, and the locomotive system, while the female determines the internal structure, the vital organs, and, in a larger proportion than the male, the constitutive temper and habits.

From the work of Mendel and his followers it is now realized that the dominant parent, regardless of the sex, determines the characters of the offspring, except in cases of six-limbed inheritance.

THE ENVIRONMENT IN BREEDING.

Though in the reproduction of domestic animals the breeder is the chief factor, one must be careful while magnifying the breeder's office to make due allowance for the part played by the environment.

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In some cases the part played by the breeder is limited to selecting from amongst the individuals, not eliminated by the environment, those nearest to the type aimed at, and thereafter deciding with which males the females are to be mated. Hence with some of the tame animals (such as range cattle and mountain sheep), as is the case with some wild forms, the environment may be of supreme importance.

The more we study wild animals the more evident it becomes that in form, color, and behavior they are marvelously adapted for their surroundings. The only satisfactory way of accounting for this adaptation is the one provided by the doctrine of natural selection—the forms now living fit their respective habitats because the environment has selected the varieties best adapted for the conditions which at the moment prevail, the races which failed to vary sufficiently to provide material for a changing environment to select from having disappeared.

It is hardly necessary to point out that some domestic animals are so well adapted for their surroundings that, if allowed to run wild, they would survive without undergoing any marked change in either form, color, or behavior. But while some domestic breeds are nearly as well adapted for their surroundings as wild animals, others have been so modified by artificial selection that were they set free they would be rapidly exterminated.

In the case of some wild animals man forms an important item in the environment, but not a few still live and move and have their being without at any time coming within the range of human influence. Man comes into contact with, and more or less influences, wild forms as a sportsman and as a fisherman; as a stock owner, as an agriculturist, and in many other ways. His influence may be so limited that it is barely appreciable, or so profound that it eventually leads to extinction. In some cases, by providing food and shelter, by eliminating weaklings and now and again introducing fresh blood, man places wild animals in nearly the same position as domestic animals.

In the reproduction of wild animals there is a limit to the part played by the environment, and in the reproduction of domestic animals there is a limit to the part played by the breeder. The environment determines which varieties shall survive and thus provides the best available material possible for the reproduction of the species. But while the environment secures that on an average the fittest wild varieties survive, it never interferes with their mating. In some cases (notwithstanding Wallace's criticism of Darwin's doctrine of sexual selection) the females select their mates, in other cases which of several possible mates will eventually be available is settled by combat, while in others there is no evidence of selection by the females and little or no evidence of conflict between the mal

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THE EFFECT OF ENVIRONMENT ON VARIATION.

It has often been assumed that the environment is a direct cause of variation; that is, it leads to the appearance of new varieties. Recently Prof. Klebs pointed out that under very favorable conditions of nutrition a rosette of the houseleek, *Sempervivum funckii*, "ripe to flower, can be transformed again into a vegetative one, which must always grow without sexual reproduction," "that flowers vary in an exceedingly high degree under certain conditions," and that some of the seedlings derived from seeds of flowers artificially altered "showed surprising deviation in their flowers."[1] It thus appears that by modifying the environment of certain plants the formation of flowers can be arrested or the flowers may be made to vary to a remarkable extent, and, more striking still, variations artificially acquired are transmitted to some of the offspring.

That some of the lower animals vary with their surroundings is indicated by the behavior of the shrimplike crustacean *Artemia*.[2] In a lake near the Black Sea with water containing 25 per cent of salt *Artemia mülhausenii* is common. In this species, which only occurs naturally in water having at least 25 per cent of salt, the tail ends abruptly in two short, blunt, round lobes devoid of hairs and bristles. In an adjoining lake with water having only 4 per cent of salt there occurs *Artemia salina*, a brine shrimp characterized by a tail which ends in two long, pointed lobes, each provided with numerous hairs and bristles of a peculiar structure.

Artemia mülhausenii succumbs if transferred from water having 25 per cent to water having only 4 per cent of salt, and *A. salina* is just as incapable of withstanding a sudden change from water having 4 per cent to water containing 25 per cent of salt. But if the amount of salt is reduced very slowly *A. mülhausenii* can be induced to live in water having 4 per cent of salt. As the amount of salt is reduced *A. mülhausenii* is gradually altered until it is eventually identical with *A. salina*. By gradually increasing the saltness of the water *A. salina* can be again transformed into *A. mülhausenii*. On the other hand, when the amount of salt is reduced *A. salina* assumes the form of *A. branchipus*, a form so different from *A. salina* that it was originally placed in a different genus. Because changes in the environment—in the food, light, temperature, etc.—lead to remarkable changes in the houseleek, and because by altering the salinity of the water the brine shrimp *Artemia mülhausenii* is transformed into *A. salina*, it does not follow that the environment is a cause of variation, but rather that in certain forms there are latent possibilities which undergo development when the appropriate stimuli are applied.

[1] Nature. June 2, 1910, p. 414.

[2] Schmankewitch. Zeitschrift fur Wissenschaftliche Zoologie. Vol. XXV.

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Breeders and writers on the principles of breeding with rare exceptions assume that the environment has played an all-important part in the making of domestic animals.

In the Cyclopedia of American Agriculture[1] Prof. F. B. Mumford says:

The principal causes of variation are unquestionably climate and food, and of these the greatest single cause is excessive food supply.

In support of the statement that climate and food are principal causes of variation it is mentioned that horses taken to the barren and cold islands of Shetland become gradually smaller and hardier, like ponies, and the hair becomes thicker and longer, while horses taken to the rich lowland pastures become larger and more powerful. Undoubtedly the environment and especially food profoundly influence the size of both plants and animals, but there is no specific difference between a large pine and a pine dwarfed by skilled Japanese gardeners, or between an Indian washerwoman's 8-hand donkey and an Italian donkey measuring 15 hands at the withers. No one doubts that individuals living under unfavorable conditions—provided with little food and little or no shelter—are smaller than individuals living under favorable conditions, but a difference in size does not entitle a race to be regarded as belonging to a different species. Moreover, reduction in size is probably never entirely due to the climate and food; there is in addition selection and probably also in-and-in breeding. In the case of the washerwoman's donkey there is spontaneous variation as in more favored races. The small varieties capable of subsisting on a very limited amount of the poorest kind of food have a better chance of surviving than larger and perhaps more fastidious varieties.

In the case of horses taken to barren and cold islands, there is more scope for selection than in the case of donkeys, because domestic horses include small as well as large species amongst their wild ancestors, whereas domestic asses have apparently all sprung from one and the same species—the wild ass of Nubia. In prehistoric times there were two small species of horses in Britain, one with a fine narrow face and slender limbs and one with a short, broad face and coarse limbs. During the first century of the present era the fine-limbed race was represented in the south of Scotland by ponies between 11 and 12 hands at the withers and the broad-browed race by ponies between 10 and 11 hands. It is not recorded when horses first reached Shetland, nor yet is anything known of the size or breeds of the individuals first introduced. But from the first century onward Scotland, in addition to small native breeds, has had foreign breeds measuring from 13 to 15 hands at the withers. If large as well as small varieties found their way to the northern

[1] Cyclopedia of American Agriculture, Vol. III, p. 34.

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islands the probability is that in the struggle for existence the small varieties had the best of it. That this actually happened is, I think, proved by the fact that Shetland ponies taken to the rich lowland pastures remain small, however favorable the surroundings.

Animals living in a wild state, in addition to being closely adapted to their environment are, as a rule, extremely stable. Wild species are stable because individuals out of touch with the surroundings are eliminated. In the case of domestic animals, mutations as well as slight fluctuations around the specific mean are often selected by the breeder. This causes a loss of stability and results in domestic animals being sometimes out of sympathy with their environment.

In studying the influence of the environment we must bear in mind that all animals have a capacity for growth and that this growth takes place when the necessary stimuli are applied in the form of food, heat, exercise, etc. Some writers on heredity make no allowance for this power to grow in several more or less fixed directions, and they also forget that, owing perhaps to the molecular instability of the germ plasm, there is a tendency to grow in new directions—to vary spontaneously quite regardless of the environment.

Others fail to distinguish between quantitative and qualitative variations. Prof. Mumford realizes that there is "in most animals an inherent tendency to vary." Nevertheless (perhaps because he fails to distinguish sufficiently between quantitative and qualitative variation) he asserts that climate and food are the principal causes of variation.

In the history of an early Spanish voyage it is recorded that a female rabbit having had a litter of young on board, they were all turned loose on the small uninhabited island of Porto Santo, near Madeira. This was about 1419, and from these alone the island became fully stocked and remains so still, although the island is now fairly peopled. When half a century ago Darwin examined living and preserved adult specimens of the Porto Santo rabbit be found that, compared with the wild English rabbit, they were little more than half the weight and nearly 3 inches less in length; that the supraorbital processes of the frontal bone were narrower; that they differed in color, the upper surface being redder and the lower grayer, and the upper part of the tail being reddish brown instead of blackish gray; further, the tips of the ears were without the black edging of our wild rabbits. Moreover, the Porto Santo rabbits kept in the Zoological Gardens were unusually wild and active and almost nocturnal in their habits.

The reduction in size, Russel Wallace thinks, might be accounted for by the larger, more bulky, slower-moving individuals being more easily captured, and that the change in color was due to the least con-

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spicuous individuals having had the best chance of surviving. As their enemies increased only the small agile protectively colored individuals would have a chance, and eventually only those which adopted the nocturnal habit and were extremely wild would survive long enough to leave offspring. These and other changes (with perhaps the exception of the change in the color of the ears) were not due to the direct action of the environment, but as Russel Wallace points out, "(1) to rapid powers of multiplication; (2) to that small amount of variability which we know occurs in all such animals; and (3) to rigid selection through diurnal and nocturnal birds of prey." That the absence of the black edging to the ears was due to the environment may be inferred from the fact that the tips of the ears of the specimens kept in the Zoological Gardens in course of time acquired black edging.

In a series of articles on heredity published in the Live Stock Journal, it is asserted that the environment not only induces quantitative variation but is the chief, if not the only, cause of qualitative variation. Prof. Wrightson,[1] the writer of the articles, states that if the environment is not the cause of variation, the only way of acounting for "animals suiting their environments is that they were so created—the white bear for the polar regions, the white hare for the snowclad hills." Prof. Wrightson further states that "any quality which has been developed within, say, 100 years from the present time, must be an acquired property, and that it is transmissible to offspring appears quite patent to anyone. If it were not so, there can be no safety in pedigree." Amongst characters caused by the environment are included early maturity, the development of fattening properties, the intelligence of shepherd dogs, the courage of bulldogs, and the speed of racehorses.

It is apparently assumed by Prof. Wrightson that one set of conditions, regardless of the breed, induce early maturity and the development of fattening properties; that by generations of training, regardless of selection and inborn aptness, shepherd dogs have acquired intelligence and bulldogs courage, and that by strenuous exercise horses under certain conditions acquire fleetness.

Breeders and others who regard the environment as the principal cause of variation make little or no allowance for spontaneous variation. It is hardly necessary to point out that wild animals living in captivity vary regardless of the conditions; some thrive better than others and mature earlier, and some members of the same brood or litter excel in courage or intelligence, speed, or agility.

By crossing experiments it is easy to prove that all the breeds and strains of pigeons are related to the blue-rock pigeon, *Columba livia*,

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[1] Prof. Wrightson's views on heredity and variation seem to be widely held by English breeders.

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and that all the tame rabbits are related to the common wild brown rabbit. Rabbits and pigeons are bred and reared under very similar conditions all the world over. If the environment is the chief cause of variation tame rabbits and pigeons ought to be all very much alike instead of being represented by numerous varieties. We have a great variety of rabbits and pigeons, not because of the influence of various kinds of environments, but because spontaneous variation has provided fanciers with abundance of material for selection.

That some breeds mature early, that shepherd dogs are intelligent, and that racehorses are fleet can be more easily accounted for by spontaneous variation and selection than by the environment. Though the environment is not, as Mumford and Wrightson assume, a principal cause of qualitative variation, the surroundings, by selecting some and eliminating others, play an extremely important part in deciding the fate of domestic as well as wild animals.

Mr. Hagenbeck in his book on "Beasts and Men" says he is "convinced that it is possible to transplant lions to any climate whatsoever," and that if allowed out in the open during spring when they are young, the weather will trouble them very little when mature, even if allowed out every day during winter.

When we consider that not a few wild tropical forms can adapt themselves to subarctic conditions, and that certain arctic species can live and multiply within the Tropics, it is not surprising that many domestic animals readily adapt themselves to new surroundings. In some cases a change in the surroundings proves highly beneficial and gives a race a new lease of life, but animals which have long lived under domestication find it impossible to support life under certain changed conditions. Arab horses if provided with shelter may be allowed to run out summer and winter in the south of England, but they sooner or later succumb if turned out on a moor in Scotland where Highland ponies thrive.

Though it is impossible to outwinter Arabs bred in Scotland in the vicinity of the Pentland Hills, ponies imported from Java after a time become acclimatized and withstand the trying Scotch winter nearly as well as Iceland ponies. Perhaps the Java ponies do better than Arabs because they acquire a heavier coat and being under 11 hands more readily find shelter. Strangely enough, the wild horses from Mongolia find the climate of Scotland rather trying; during rainstorms in spring they seem to suffer acutely. Doubtless Prejvalsky's horse dislikes the conditions which prevail in spring in Scotland, because in his ancestral home, the Gobi Desert, the annual rainfall is very low—only 8 to 10 inches.

This view is supported by the behavior of a Mongolian pony, one of the foster mothers imported with the Prejvalsky foals. This mare did badly on a moor which proved most suitable for native

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ponies. Moreover, her yearling filly by an Arab died, and subsequently her yearling hybrid by a Prejvalsky stallion did so badly that he also died. On the other hand, three other Prejvalsky hybrids (out of Highland ponies) which grazed along with the Mongol hybrid have always been in excellent condition. It thus appears that an environment which proves highly suitable for one breed of horses may prove disastrous to other breeds.

This is also true of cattle. Highland cattle, for example, flourish where other breeds languish and die; but even the hardiest breeds of cattle sometimes succumb during winter in areas where horses manage to get a living.

One of the most important parts of a breeder's work is to study the environment with a view to finding out what amount of food and shelter his stock requires during winter, more especially if he has imported animals which for generations lived under conditions unattainable in their new habitat. Apparently southern forms are better able to adapt themselves to a cold environment than northern forms to tropical conditions. English breeds of dogs are said to degenerate rapidly in India; northern breeds of sheep transplanted to the West Coast of Africa lose nearly the whole of their wool and are otherwise modified, and even fat-tailed sheep when removed from their saline pastures are said to lose their great accumulations of fat. Horses seem incapable of surviving in some parts of India, and even in the vicinity of the Himalayas, where horses have flourished since Pliocene times, certain European breeds do badly. In Gondal (Bombay Presidency) Shetland ponies manage to survive and breed, but hitherto the foals have, I am informed, succumbed during the first year.

When it is reported that an environment is unsuitable for a breed, it is always well to inquire if sufficient food is provided. A century ago about one-fifth of the cattle in the western islands of Scotland died every winter, but the high death rate was due not so much to the cold and damp climate as to the scarcity of food.

THE EFFECT OF ENVIRONMENT ON EARLY MATURITY.

Though a breed may survive under new conditions it may prove sterile or fail to bring forth offspring capable of surviving, or the offspring if they survive may be poor specimens of their race. Sometimes a race may prove almost sterile when first introduced, but fairly fertile later, and the fertility may increase as the new race gets better adapted to the new conditions. Whether a new race will prove profitable will often depend to a considerable extent on the time it takes to reach maturity. It is generally assumed that early maturity is the result of long-continued selection, but it is well to bear

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in mind that under unfavorable conditions members of a race having a reputation for early maturity may mature slowly, while members of a race supposed to develop slowly may, under favorable conditions, mature rapidly. There are very few statistics showing the influence of favorable and unfavorable conditions on members of the same family. Under unusually favorable conditions a filly reaches maturity when 11 months old, and may have a foal when only 22 months old; but when the conditions are extremely unfavorable mares running with stallions may not become pregnant until they reach their third year. Dogs, it is said, sometimes reach maturity when 6 months old. One of three bitches belonging to a litter of crossbred terriers reared under favorable conditions reached maturity when 7 months old; in the other two maturity was reached 6 weeks later, but all 3 were in "heat" at the same time when 15 months old.

In Scotland red deer seldom have antlers with 12 points before the sixth year, but a stag reared under very favorable conditions may have 10 or 11 points when 2 years old and 12 or more when only 3 years old.

INFLUENCE OF ENVIRONMENT DURING DEVELOPMENT.

Some years ago I found in a wild rabbit 12 young, 8 in the right uterus, 4 in the left. The 8 in the right uterus were of uniform size and quite as advanced in their development as the 4 (also uniform in size) in the left uterus, but they were only half the size. When the 8 were placed in one scale of a balance, and the 4 in the other, the 4 were found to weigh a few grains more than the 8. In this case the 4 fetuses had evidently received the same amount of nourishment as the 8, and were, moreover, able to assimilate all they received. Had these 12 young been born, the 8 small ones might, in course of time, have reached the same dimensions as the 4 large ones. Very often in a litter of rabbits 1 or 2 of the young are small and soon die off, but I once succeeded in rearing a rabbit that, even when nearly 6 weeks old, was little more than half the weight of the other members of the litter. Eventually this dwarf reached nearly the size of its half-wild parent, and produced perfectly normal offspring. By way of testing the influence of the immediate surroundings during development, I placed a doe rabbit in a cellar that was insanitary and unsavory, with a north light through which the direct sun's rays never penetrated during winter or spring. This doe (after being mated with a half-wild buck) was placed in the cellar on the 9th of April, and returned to her hutch on the 8th of May, the day before her young were due. The young only arrived on the 12th of May, when, as it happened, I saw them born. There were 6 in all, 2 were dead at birth, and the remaining 4 all died within 24 hours. Since this unhealthy litter the doe has produced 38 young, all perfectly normal.

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Of these, 6 to the same buck were born after a second sojourn in the cellar; but during the second stay of 4 weeks the cellar was in part flooded almost daily with sunshine, and it was, moreover, better ventilated. In the above instance, though plenty of good food was provided, the period of gestation was prolonged, and the vitality of the young enormously reduced.

This experiment seems to lend support to the view that animals bred under unfavorable conditions are not likely should they survive to be a credit to their ancestors. But apparently this conclusion is unwarranted. At any rate, a recent investigation seems to show that if the parents belong to a good stock the offspring, even if reared under adverse conditions, may, notwithstanding an unfavorable start in life, eventually develop into fine specimens of their race.

There are very few observations on the rate of growth under different conditions. The foal of a well-bred 14-hand mare by a sire about the same size as a rule measures at birth from 36 to 36½ inches at the withers; the length from the elbow to the ground is 25 inches, and from the hock to the ground 18 inches. During the first 3 months the height is increased by 8 to 9 inches, the forelimb by 5 inches, and the hock is higher by 2 inches. The second 3 months adds 3 inches to the withers; at the end of the first year the height at the withers is 53 inches, at the end of the second year 56 inches, and at the end of the third year 57 inches. From the end of the third month to the end of the first year the forelimb (from the elbow to the ground) increases 3 inches, and the hock is higher by 1¼ inches, but during the second and third years the increase of the forelimb is only one-quarter of an inch, and there is no increase in length from the hock to the ground. The circumference below the knee, 4¼ inches at birth, is 5¾ at the end of the third month, 6 inches at the end of the sixth month, 6¼ at the end of the first year, 6¾ at the end of the second year, and 7½ at the end of the third year.

When the foal of a 14-hands mare is small at birth and poorly nourished, during the first three years it may only measure 49 inches when 12 months old and 53 inches when 3 years old, the circumference below the knee being only 6½ inches. When, however, a foal measuring 36 inches at birth is reared under extremely favorable conditions (in, say, the Argentine or Australia), the height at the withers at the end of the first year may be 14 hands and at the end of the third year 15 hands, with a circumference below the knee of 8 inches.

This difference is mainly due to steady increase in the length of the limb bones from the fifth to the ninth month (when, under ordinary circumstances, the growth is retarded) and to there being a plentiful supply of lime salts to provide for the increase in the width of the metacarpals during the second and third years.

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One result of forcing, if the colt happens to belong to a high-withered race, is a considerable increase below as well as above the knees, which generally means legs incapable of standing ordinary wear and tear.

The form of the skull, as well as the length and strength of the limbs, to a certain extent depends on the environment. In steppe forms for some reason or other capacious nasal chambers seem advantageous; hence in the Saiga antelope and in the wild sheep and the wild horse (*Equus przewalskii*) of central Asia the nasal bones bulge outward during the period of growth, with the result that there is eventually produced a characteristic "Roman nose."

In many parts of northwestern Europe the conditions differ profoundly from those prevailing in central Asia. In the Shetland Islands, instead of wide-stretching deserts and plateaus and a cold dry climate, there are extensive moors but little above the sea level, and throughout the greater part of the year the atmosphere is saturated with moisture and the temperature in winter is never either very high or very low. Perhaps owing to the mild, moist climate there is no need in Shetland for capacious nasal chambers. Be this as it may, the concave condition of the face found in most mammals at birth tends to persist in Shetland, with the result that the nasal chambers in the adult are shallow, and instead of a pronounced "Roman nose" we usually find a short, broad, dished face in the ponies and a nearly straight profile in the short-tailed native sheep. In the same way cattle vary. Under one set of conditions the face is short and broad, in others long and narrow. It is short and broad in the banting and other species which frequent dry upland regions, but long and narrow in the marsh-loving buffalo.

There is no evidence so far as I am aware that in the case of domestic animals the environment initiates or is a direct cause of variation. But though it may not initiate new structures it may lead to the increase or diminution of existing structures (that is, induce quantitative variation) or lead to the development of latent structures.

That the length of the hair and the condition of the skin vary with the environment has long been realized, but it is not sufficiently realized that the surroundings may lead to modification of the skeleton. Until a few years ago there was in Norway a very short-legged race of ponies, known at the "udganger" pony, or Nordlandshest. As ponies of the udganger type but with perfectly normal legs still occur in Iceland, it may be assumed that the dwarfing in the more ancient Norwegian variety was due to an extremely unfavorable environment which eventually led to extinction.

It is well to bear in mind that some animals respond to external stimuli—adapt themselves to new conditions—more readily than others. As a general rule inbred varieties which occupy limited

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areas in which the conditions vary little throughout the year are less likely to adapt themselves readily to new and different surroundings than varieties represented by numerous races continuously distributed over a wide area.

It is often stated that it is impossible to maintain a European breed of domestic animals at a high standard in America unless fresh blood is periodically introduced from the original home of the race. To what extent "points" are lost by, say, British breeds of cattle and sheep by a change from the Old World to the New can only be determined by the examination of purebred herds and flocks which for several generations have been bred and reared in different parts of America.

TRANSMISSION OF ACQUIRED CHARACTERS.

The doctrine, especially associated with Lamarck, which teaches that acquired characters are transmitted is so fully dealt with in recent works on heredity that it need only be shortly referred to. That the body or soma is capable of being modified before as well as after birth is universally admitted, but few biologists now admit that modifications acquired by the soma can be so imprinted on the germ plasm that they reappear in the offspring.

It is no longer generally admitted that acquired characters are heritable because, as Prof. E. B. Wilson [1] has pointed out—

> It is a reversal of the true point of view to regard inheritance as taking place from the body of the parent to that of the child. The child inherits from the parent germ cell, not from the parent body, and the germ cell owes its characteristics not to the body which bears it but to its descent from a preexisting germ cell of the same kind. Thus the body is as it were an offshoot from the germ cell. As far as inheritance is concerned the body is merely the carrier of the germ cells which are held in trust for coming generations.

That the offspring inherit from the germ plasm, not from the soma in which the germ plasm is stored, is also insisted on in similar terms by Mr. Archdall Reid, who says: "Individuals, for example men, are nothing more than dwellings which the germ plasm builds about its germinal descendants," hence "the child inherits nothing from his parent." What it does inherit are the characters in the germ plasm from which it started, not the characters of the casket in which the germ plasm was preserved.

All that the fertilized germ cell requires at the outset, in order to produce a new "dwelling" or soma and a new crop of germ cells like unto itself, is the stimulus of nutrition. If as development and growth proceed there is in addition to the stimulus of nutrition the stimulus of use, the body will have the chance of becoming a suitable dwelling for the next generation of germ cells; but without use the

[1] The Cell in Development and Inheritance, p. 13.

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bones and muscles will be imperfectly developed and the mental powers will remain dormant. Hitherto breeders, as a rule, have found it difficult to believe that modern biologists really mean what they say when they assert that modifications of the body and mind of the parent acquired during the lifetime (i. e., modifications not represented in the germ plasm from which the parents were developed) are not transmitted. They agree with Prof. Wrightson that the speed of the modern race horse has in part resulted from many generations of training and that the intelligence of the modern sheep dog is in part due to the mental efforts of his ancestors. Some adherents of the doctrine of Lamarck point out that Darwin thought the surroundings, and the effects of use and disuse, led to modifications of the germ plasm which could be transmitted to succeeding generations. Others remind us that Herbert Spencer's ethical system was built on the assumption that the germ plasm is so responsive to stimuli that it is liable to be permanently influenced by modifications of the mental as well as of the bodily powers.

Though breeders seem to have no difficulty in believing that modifications of the soma are represented by corresponding modifications of the germ plasm (that, for instance, changes in the wool of sheep lead to changes in the "units" in the germ plasm concerned with the formation of the coat), Darwin was so impressed with the difficulty of transmitting somatic modifications to the offspring that he invented the doctrine of "pangenesis," which teaches that by means of invisible gemmules every change in the organs and tissues of the adult is duly registered in the germ cells. If, however, it is clearly realized that the parents are not represented in the germ cells, either by gemmules or in any other way, the difficulty of escaping from the paralyzing influence of the transmission doctrine will be diminished and the important part played by spontaneous variation in providing material for the production of new varieties more widely recognized.

That breeders have so long believed in the influence of maternal impressions, in the "infection" doctrine, and in the transmission of acquired characters is partly due to the difficulty of realizing the independent nature and the continuity of the germ plasm, and partly to the fact that hitherto the most influential writers on the laws of breeding have, with rare exceptions, been followers of Lamarck. Reference has already been made to the views advocated by Prof. Wrightson in England. Similar views have been promulgated by writers in America.

We have, for instance, Prof. Brewer, widely recognized as a great authority on all matters connected with agriculture, supporting the views commonly accepted by breeders. Some years ago Prof. Brewer wrote:

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The art of breeding has become in a measure an applied science, the enormous economic interests involved stimulate observation and study, and what is the practical result? The 10 years of active promulgation of the new theory—the continuity of the germ plasm—has not resulted in the conversion of a single known breeder to the extent of inducing him to conform his methods and practice to the theory. My conclusion is that they are essentially right in their deductions, founded on their experience and observations, namely, that acquired characters may be and sometimes are transmitted, and that the speculations of the Weismann school of naturalists are unfounded.[1]

Anyone who tells the breeder things he firmly believes is hailed as a prophet, but he ceases to be a prophet when the breeder, from experience, is forced to change his creed. At the present time several tenets in the breeder's creed are undergoing considerable modification owing to the rapidly increasing practice of making milk records. In some districts it is believed that if cows are allowed to "go dry" early in the season their offspring will prove indifferent milkers, and until recently it was widely believed that the quantity and quality of the milk were mainly a question of food, and that the offspring of well-fed cows would prove good milkers. Since the plan of systematically weighing and testing the milk of each cow was adopted it has been ascertained that two cows of a like age, belonging to the same breed, which calved at the same time, received the same rations, and lived under identical conditions, may vary greatly in the quantity and quality of the milk they yield. If of two cows living under similar conditions and receiving the same amount of food one yields 800 gallons while the other only gives 200 gallons, and further, if the offspring of a poorly fed cow sometimes yields four times as much milk as the offspring of a well-fed cow, it is difficult, notwithstanding preconceived opinions, to escape from the conclusion that food may not be a principal cause of variation and that acquired characters (that is, the habit in cows of giving little milk when allowed to "go dry" early) are not transmitted.

From a study of milk records alone many breeders will in time be led to conclude that the quantity and quality of milk are separate inheritances (due to two distinct variations) which by selective breeding may be combined in the same individual. This will in due course lead to the further conclusion that there is a profound difference between a modification of an organ due to use or disuse, or to food or other changes in the surroundings and a modification due to a change in the germ plasm.

It is doubtless true that we make new strains and new breeds, but we do not make the material out of which the new strains are constructed. By means of unfavorable conditions—insufficient or unsuitable food, want of exercise, and the like—we may arrest the de-

[1] Thomson's Heredity, p. 193.

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velopment and growth of the entire organism or of some of its parts, or by extremely favorable conditions we may bring almost every part of an organism to a high state of development. Material is available for making new strains, because all plants and animals vary. Why they vary is still a mystery, for though we say they vary because of the molecular instability of the protoplasm we do not account for variation.

All that we know is that the offspring of plants and animals now and again present one or more new characters. Though these characters can not be isolated and experimented with, they may be regarded as "units" analogous to the molecules of the chemist. When varieties possessing different kinds of units are crossed there may be a rearrangement of the units, with the result that we obtain a variety in which the units or characteristics of two or more varieties are combined. If this new combination is stable we obtain a new strain which breeds true.

IMPORTANCE OF KNOWING THE ANCIENT CHARACTERISTICS OF DOMESTIC BREEDS.

As most wild species consist of several varieties, so must domestic breeds consist of several strains. Up to a certain stage in their development all the pure strains of a breed are presumably identical in structure. But sooner or later the characteristic features of each strain are developed. The breeder has little control over the ancient characteristics common to all the strains of a breed, but by crossing he can make new combinations of the more recently originated traits. It hence follows that breeders should know as much as possible of the characteristics and history of all the strains which make up the breeds he happens to be interested in.

In addition to knowing the history and characteristics of the different strains, it is desirable that breeders should know as much as possible of the origin and history of the breeds formed by the strains. The first question to be asked about the breeds of domestic animals is, "Are they descended from one or from several wild species?" It is admitted that all the numerous breeds of domestic pigeons are descended from varieties of the wild blue-rock pigeon *Columba livia*, and that domestic rabbits are all related to varieties of the wild brown rabbit *Lepus cuniculus*. On the other hand it is admitted that dogs and cats had a multiple origin. But zoologists are less certain about the origin of domestic horses, sheep, and cattle.

It might be said that while the history of the domestic breeds may claim the attention of zoologists it does not concern the practical breeder. If all the breeds were pure and bred true, this might be admitted, but if, as is certainly the case, some of the so-called pure breeds are made up of perfectly distinct types which centuries of

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interbreeding have failed to blend into a uniform race, it is most important that breeders should know as much as possible about the characteristics of the prehistoric wild races to which the different types are related. When two strains are crossed there is often marked reversion. If the crossing of two similar strains sometimes leads to the loss of "points" gained by careful selection, it need hardly be said that the crossing of tribes or strains made up of distinct types will almost inevitably lead to marked reversion. This being admitted, it follows that it is quite as important to direct attention to the origin and history of the breeds as to the conditions under which they live.

ORIGIN OF DOMESTIC SHEEP.

In a chapter on the origin of domestic sheep in the Cyclopedia of American Agriculture[1] it is said: "Our domestic sheep have probably been derived from more than one species of the genus *Ovis*. They are supposed to have been descended from the argali or wild sheep of Asia (*Ovis ammon*) and the musimon of the south of Europe (*Ovis musimon*)," but "whether these two wild forms are really to be regarded as distinct species, and whether our common sheep have descended from them, or one of them, directly or from a related form now extinct, are questions that do not appear to have been settled by zoologists." Though it is true that zoologists have not settled from which wild ancestors modern sheep are descended, it may be mentioned that Prof. Dürst is convinced that he has made out the origin of the "turbary" sheep (*Ovis aries palustris*) which seems to have accompanied Neolithic man in all his wanderings.

From material collected at Anau Prof. Dürst is satisfied that *Ovis aries palustris* Rütimeyer was evolved in Turkestan from the native wild urial (*Ovis vignei*), that from Turkestan it found its way into Europe where it was widely distributed in prehistoric times. In a map Dürst indicates the present distribution of the urial, the distribution of its descendant *Ovis aries palustris* in prehistoric and early historic times, and also where he believes it still survives. Dürst assumes that as the urial was modified to form the turbary sheep the tail was gradually lengthened, and he thinks that the fat-tailed sheep of the Afghan Maimene race was perhaps derived from *Ovis palustris*. There is, however, no evidence as far as I am aware that the turbary sheep had a long tail. In addition to the ancient turbary sheep, characterized by "thin tall legs and horns like a goat," there existed in prehistoric times a sheep with large curved horns (*Ovis aries studeri*) and also a "four-horned" sheep.

The zoologist is not only expected to work out the origin and history of the turbary sheep, of Studer's sheep, and of four-horned

[1] Vol. III, 1908, p. 596.

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sheep, but also to determine, if possible, the origin of both horned and hornless modern breeds.

The Ovidæ family includes the true sheep belonging to the genus *Ovis*, the so-called blue sheep of Asia (*Pseudovis*), the so-called Barbary sheep (*Ammotragus*) of north Africa, and the various kinds of goats. True wild sheep (characterized by a short tail, by a sub-orbital pit for a scent gland, and by a gland between the toes of both fore and hind feet) either resemble the mouflon or the argali. The mouflon section includes the European and Asiatic mouflons (as *Ovis musimon* and *Ovis orientalis*) characterized by large curved horns and a shallow face pit, and the urials of Asia (as *Ovis vignei*) with large curved horns and a deep face pit. The argali section includes in addition to *Ovis ammon*, *Ovis poli*, and *Ovis hodgsoni* of Asia, the bighorns (as *Ovis canadensis*) of Asia and America.

SHEEP OF THE MOUFLON TYPE.

Though it has often been asserted that the wild ancestor of domestic sheep is "not only extinct but totally unknown," there are still domestic sheep in existence which, apart from their coat, closely resemble the mouflon. Of these mouflon-like races or breeds the most interesting is the one found on the island of Soay, a member of the St. Kilda group of islands lying in the Atlantic about a hundred miles from the coast of Scotland. Soay, an uninhabited island about 1 mile in circumference, is so precipitous that it is only visited on rare occasions by the natives of St. Kilda. How and when sheep first reached this "Sheep Island" it is impossible to say. In its skeleton the Soay sheep agrees with Studer's sheep, which reached Britain during the Bronze age and persisted apparently unaltered at least up to the coming of the Romans. (See Pl. VIII.)

Evidence of this we have in skulls, horns, and limb bones from Neolithic settlements and British and Roman-British villages. Further, the Soay sheep in horns, skeletons, and in the face pit, in the length of the tail, color of the limbs and face, and in the hair fringes, very closely agrees with some of the smaller varieties of the mouflon of Asia. In other words, apart from its coat (which, instead of consisting of an outer layer of hair and an inner layer of wool as in wild sheep, consists almost entirely of very fine wool), the Soay sheep is a mouflon. About the coat of Studer's sheep, during the Bronze age or even during the Roman occupation of Britain, nothing is known. Doubtless after, if not before, Studer's sheep reached Soay and other outlying islands in the north Atlantic, the individuals with most wool would have the best chance of surviving. Hence in course of time a thick coat of fine wool would be acquired through natural selection. There has doubtless been in-and-in breed-

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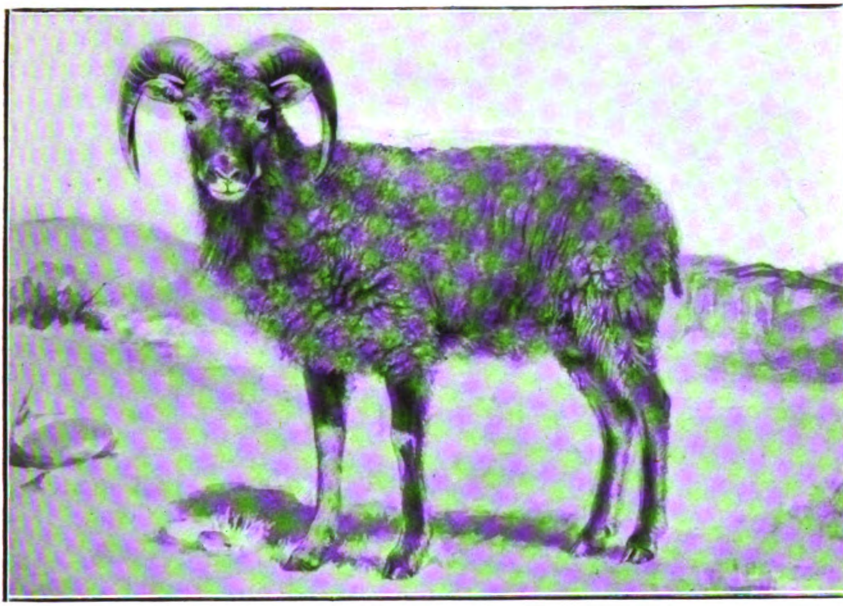

FIG. 1.—A SEMIWILD SHEEP FROM THE ISLAND OF SOAY.

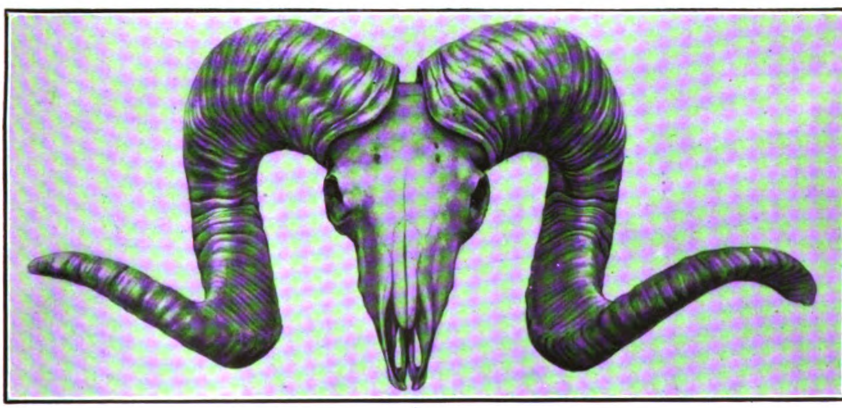

FIG. 2.—SKULL AND HORNS OF THE ARGALI.

FIG. 3.—SKULL OF A WELSH MOUNTAIN RAM, WITH HORNS OF THE ARGALI TYPE.

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ing on Soay, but, probably owing to the elimination of the unfit by the trying physical conditions, aided by the sea eagle, the raven, and the blackbacked gull, there is no evidence of loss of vigor. Neither is there evidence of marked loss of size, and, as the ewes generally have twins, there is evidently no loss of fertility. Though, when first captured, Soay sheep behave like wild animals and are always liable to disregard dikes and fences, they are easily tamed.

The question now arises, Are any of the modern domestic breeds descended from ancestors of the Soay type? Many writers on sheep not only take for granted that the wild ancestor of domestic breeds is extinct, but also that all the modern breeds are characterized by a long tail. For instance, Lydekker says: "It may be mentioned that the ancestral form of these domestic breeds, which differ from all the wild species save the arui by the length of the tail, is at present totally unknown."[1] Short-tailed sheep are not uncommon in the East, and in addition to the semiwild herd on Soay there are still short-tailed sheep living under domestication in various parts of Europe. Short-tailed sheep are still found in Norway, in the Faroe Islands and Iceland, and in Shetland and the Western Islands of Scotland. They also occur in Wales, and, half a century ago, a short-tailed race might have been met with in various parts of the west of Ireland. In the Low collection of paintings in the University of Edinburgh there is a drawing of a short-tailed Orkney sheep with horns of the mouflon type, and notwithstanding free intercrossing in many of the mooret-colored (moor-red) sheep of Shetland the tail is as short as in the mouflon and sometimes there are mouflon-like horns. Moreover, some of the Shetland sheep in the skull and limb bones exactly agree with the Soay race.

It may hence be taken for granted that Shetland and other short-tailed two-horned domestic sheep, now, or until recently, living in northwestern Europe, are descended from one or more varieties of the wild mouflon of Europe or Asia.

LONG-TAILED DOMESTIC SHEEP.

About the origin of long-tailed, horned, and hornless breeds nothing certain is known. As already said, Prof. Dürst assumes that as *Ovis palustris* was evolved from the urial (*Ovis vignei*) of Turkestan it acquired a long tail. There is not, as far as I am aware, any evidence that either *Ovis palustris* (the turbary sheep) or *Ovis studeri* (the Bronze-age sheep) had a long tail. Dürst is further inclined to assume that *Ovis palustris*, at a comparatively late period, accumulated fat in its tail and was otherwise modified to form the Afghan Maimene fat-tailed sheep.

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[1] Wild Oxen, Sheep, and Goats of all Lands. P. 151.

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It seems to me more likely that as the necessity for storing fat increased, owing to the ever-increasing desiccation of central Asia, the tail of certain eastern varieties was lengthened to provide additional storage for nourishment required during the dry season. Fat-tailed sheep are said to lose the fat from the tail when removed from their saline native pastures to Europe. It is hence possible that the long-tailed breeds of Europe are indebted for their long tail to fat-tailed eastern ancestors, the fat having gradually disappeared, partly because of artificial selection and partly owing to a change in the environment.

Some of the long-tailed breeds of Europe may have descended from the urial (*Ovis vignei*) or from mouflons, but the spiral-horned varieties were perhaps mainly derived from the argali type (*Ovis ammon*). It is conceivable that in some modern breeds the argali as well as the urial and mouflon are represented.

In its horns the Welsh Mountain ram resembles the argali, and even Scotch black-faced rams still approach much nearer to the argali type in their horns than the fashion of the moment permits.

That black-faced sheep are descended from a short-tailed race is suggested by the fact that some years ago nearly 80 per cent of the offspring of a pedigree black-faced ram and purebred black-faced ewes had the tail as short as the wild argali.

If, as seems probable, most of the modern breeds include several wild species amongst their ancestors, it follows that to maintain a strain at a high standard the breeder should know enough about modern wild races to enable him to realize why some of the most prized points are acquired with difficulty (as the low position of the horns in black-faced sheep) and with difficulty maintained.

ORIGIN OF DOMESTICATED CATTLE.

From the days of Cuvier the majority of naturalists have regarded the urus (*Bos taurus primigenius*) as only differing from the modern *Bos taurus* by its greater size. Discussing the origin of British cattle, Prof. McKenna-Hughes remarks:

> Cæsar mentions there were large herds of domesticated cattle in Britain, and we know from numerous excavations into Roman and Roman-British rubbish heaps that these belonged, not to the urus, but to *Bos longifrons*. This, then, is the native breed with which we must start in all our speculations as to the origin and development of British oxen. The Romans found that breed here and no other.[1]

Writing about the Celtic shorthorn (*Bos longifrons* Owen, *Bos brachyceros* Rütimeyer), Lydekker says "it is and can be nothing but a variety of *Bos taurus*," derived from the wild urus at a very

[1] Since this was written remains of a long-horned ox have been found in Neolithic deposits in the Thames Valley.

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remote epoch. Lydekker, though satisfied that all the domesticated breeds of European cattle must trace their ultimate ancestry to *Bos primigenius*, thinks it quite probable that the origin of the humped cattle of India (*Bos indicus*) may be, at least in part, different.

Prof. Fairfield Osborn, in his epoch-making book on "The Age of Mammals," says the domestic ox, instead of being a direct descendant of *Bos primigenius*, may be a descendant of *Bos trochoceros* of the Italian Pleistocene period, and that British shorthorn cattle are descended from an indigenous occidental race, domesticated in Europe by the Neolithic man.

While naturalists as a rule agree with Lydekker that the urus was the only wild ox in Europe and that an eastern derivation of European cattle is in the highest degree improbable, some believe our modern breeds are descended from varieties originally domesticated in Asia. Prof. Boyd Dawkins writes:

It is clear the domestic animals were not domesticated in Europe, but that they had already been under the care of man, probably for long ages, in some other region. The turf-hog, the Celtic shorthorn, the sheep, and the goat must have been domesticated in the countries in which their wild ancestors were captured by the hunter in central Asia. To this region also belong the jackal, the wild boar, and the wild horse, and, in ancient times, the urus. It is therefore probable that all these domestic animals came into Europe with their masters from the southeast—from the central plateau of Asia—the ancient home of all the present European peoples.

In the report on the animal remains collected in Turkestan by the Pumpelly expedition, Prof. Dürst states:

That the Indian (Narbada and Siwaliks) and China Taurina are the exact equivalents of the Euporean urus (*Bos primigenius* Boyanus) excepting some very slight variations produced by different geographical and local influences, so that *Bos namadicus* Falconer and Cantley would represent the European urus for the Asiatic continent, especially the North Indian mountains and their neighborhood.[1]

After stating that the Asiatic urus was modified at Anau to form a longhorned domestic race (*Bos macroceros*), Dürst proceeds to say:

The first remains of the longhorned breed (*Bos macroceros*) belong at Anau about 8,000 B. C. We find the same animal again about 3,000 to 4,000 B. C. in Babylonia and Egypt. At about 6,000 B. C., however, we find that the large longhorned animal of Anau has become small and small-boned, and had developed into a shorthorned breed (*Bos brachyceros*). Therefore, all who do not believe in an autochthonous domestication of the animals for each separate culture-sphere, must admit that the original large and stately longhorned ox of Anau was spread by tribal migrations before 6,000 B. C. to Persia and Mesopotamia and into Egypt and central Africa on the one hand, and on the other to India and eastern Asia, where, according to Chinese

[1] Animal remains from excavations at Anau, Carnegie Institution of Washington, Chapters XVI–XX, Pumpelly Expedition. Washington, 1907.

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accounts, it arrived 3,468 B. C.; and there are good grounds for believing that the ox of Anau, which about 7,000 B. C. was undergoing change of form, finally reached central Europe, after its migration through southern Russia and eastern Europe in the stunted form of *Bos taurus brachyceros.*

Prof. Boule, in his recent work on the Grotto of Grimaldi, points out that the urus appeared in Europe about the same time and was probably as common as the bison. Though the urus survived on the European Continent up to the beginning of the seventeenth century, it almost certainly became extinct in Britain before the Roman invasion. The white "wild" Park cattle of England and Scotland are hence not now regarded as direct descendants of the wild urus.

Hitherto, in discussing the origin of European domestic cattle, attention has been mainly directed to the horns and the premaxillæ. It seems to have been assumed that in occidental breeds "the premaxillæ are large and always extend upwards into the triangular space between the maxillæ and the nasals, and consequently articulate with both these bones, as in *Bubalus.*"[1]

In the bison the premaxillæ are always so short that they fail to reach the nasals. I find, however, that in polled as well as horned British breeds the premaxillæ are often so short that they fail to reach the nasals and that in some specimens of the gaur (*Bos gaurus*) of India the premaxillæ are short, as in the bison, but as long in others as in the urus. The premaxillæ, always long in the buffalo and always short in the bison, vary in the true oxen of Europe and Asia, and in the Bibovine (gaur and banting) section of the Bovidæ. In the European urus (*Bos primigenius*) the premaxillæ in all the specimens examined reach the nasals, but in the Asiatic urus (*Bos namadicus*) they are said to terminate some distance from the nasals—they are certainly short in *Bos chinensis*, presumably a descendant of *Bos namadicus.*

In the polled Galloway breed, and in the white polled Cadzow "wild" cattle, once common in Hamilton Park, Scotland, the premaxillæ reach the nasal, as in the urus, but in the polled Aberdeen-Angus cattle they are sometimes short and fail to reach the nasal, as in the bison. Though perhaps usually short in Angus cattle, they are sometimes so long that they extend upward between the maxillæ and nasals as far as in the buffalo. As it happens, the premaxillæ of a Syrian breed (in the act of losing the horns) are identical with the long premaxillæ sometimes met with in Aberdeen-Angus cattle. This resemblance suggests that the polled Aberdeen-Angus cattle include an ancient oriental race amongst their ancestors. The nature of the premaxillæ in the Chillingham and Chartley "wild" white cattle has not been ascertained, but I find that the premaxillæ are short in the skull of a horned Cadzow ox, which, taken with other

[1] Gray. Catalogue of the Ungulata in the British Museum, 1873.

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characteristics, probably implies that the urus has played an unimportant part in the making of the horned section of the Hamilton Park herd of "wild" cattle.

In the urus the frontal bones and the horn cores extend so far backward that they not only conceal the parietals but project 3 or 4 inches beyond the occipital condyles. On the other hand, in the polled Aberdeen-Angus skull, with long premaxillæ, the frontals are so short that the parietals take part in forming the forehead, as in the gaur and bison. In the urus, the temporal fossæ are closed behind—cut off from the occiput—by plates of bone which fill up the gaps between the horn cores and the occipital crest, but in the horned Cadzow skull, as in skulls from Roman military stations,

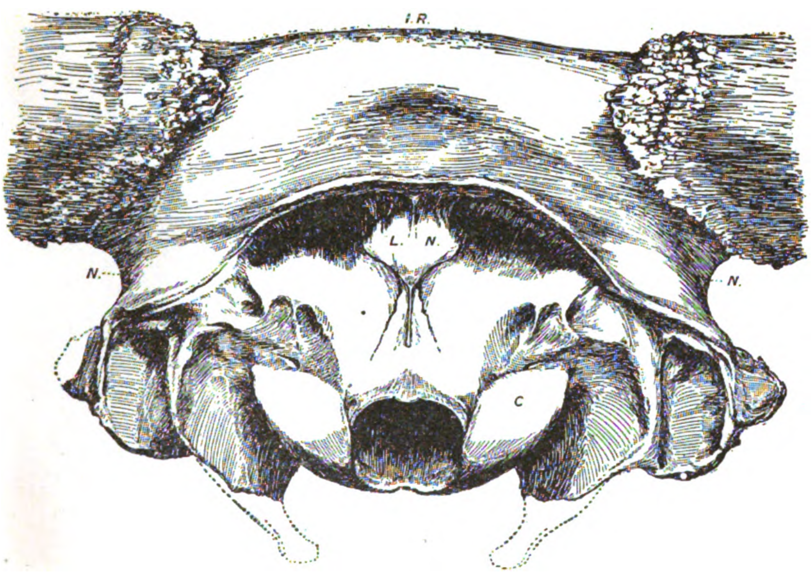

Fig. 1.—Occiput of the urus in the Anatomical Museum, University of Edinburgh.

owing to deep notches between the horn cores and the occipital crest, the temporal fossæ open freely on to the occiput.

In *Bos primigenius* of Europe, and also in *Bos namadicus* of Asia, the general outline of the occiput is quadrangular, the occipital crest flattened, and, owing to gaps on each side between the occipital crest and the horn cores being filled up by a bridge of bone which cuts off the temporal fossæ, the supracristal (parieto-frontal) part of the occiput has an extensive connection with the infracristal (occipital) part of the occiput. In many European and certainly in some Indian cattle the occiput is broad and quadrangular and more or less completely cut off from the temporal fossæ as in *Bos primigenius* (fig. 1). But since at least the first century A. D.

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there have been cattle in Britain in which the occiput differed profoundly from that of the urus. For example, in a skull from a Roman fort recently excavated in the south of Scotland, the occiput consists of two distinct parts (fig. 2), as in the gaur. There is an upper (parieto-frontal) part, continuous with the horn cores, and a lower part (including the whole of the occipital bone) separated from the upper by two deep notches, leading from the temporal fossæ. The upper portion consists of a semicircular, deeply excavated, mesial portion, and of rounded lateral portions continuous with the horn cores; the lower portion, bounded above by the semicircular occipital crest, is divided into two by the shieldlike

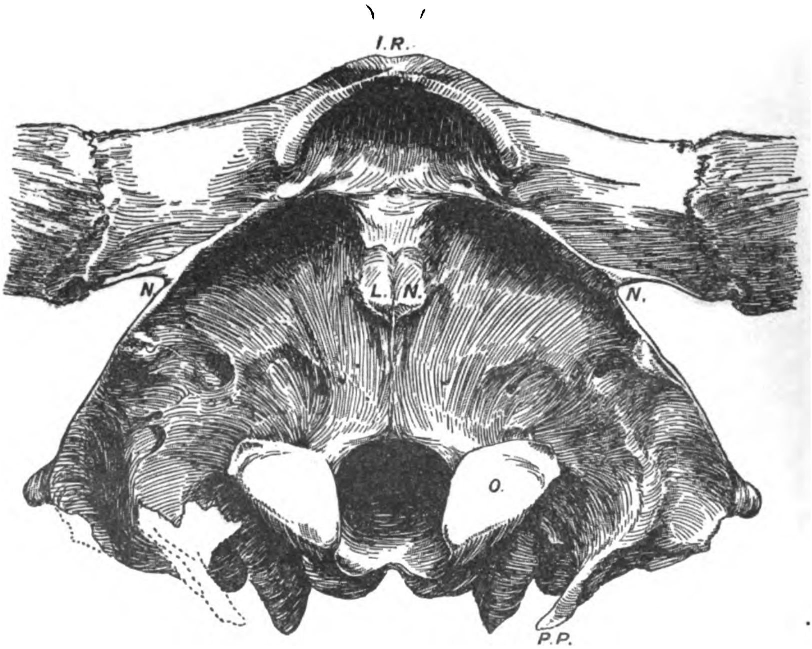

FIG. 2.—Occiput of the skull of an ox, from a Roman fort in the south of Scotland (the Newstead skull).

projection for the ligamentum nuchæ and a mesial ridge which extends from the "shield" to the foramen magnum. Viewed from behind, a skull with deep notches below the horn cores appears to have an occiput nearly intermediate between that of *Bos gaurus* (fig. 3) and *Bos primigenius.*

The skull of the Cadzow ox very closely resembles the skull from the Roman fort near Melrose in the south of Scotland. These skulls evidently belong to a race very different from *Bos primigenius* and *Bos namadicus* of Pleistocene deposits and from the Pliocene *Bos planifrons*, regarded as the remote ancestor of all the modern oxen. But they, in many respects, resemble *Bos acutifrons* of the Punjab

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Siwaliks, which, in having the upper part of the occiput continuous with the horn cores, separated from the lower part, is decidedly less specialized than either the European or Asiatic urus.

A preliminary examination of the skulls at present available for study has led to the following conclusions:

1. That the Celtic shorthorn (*Bos longifrons*) is probably more intimately related to zebus with horns of the *longifrons* type than to *Bos primigenius.*

2. That the black-polled Galloway and the white-polled Cadzow cattle are closely related to *Bos primigenius*, while some of the black-polled Aberdeen-Angus cattle are probably in part descended from

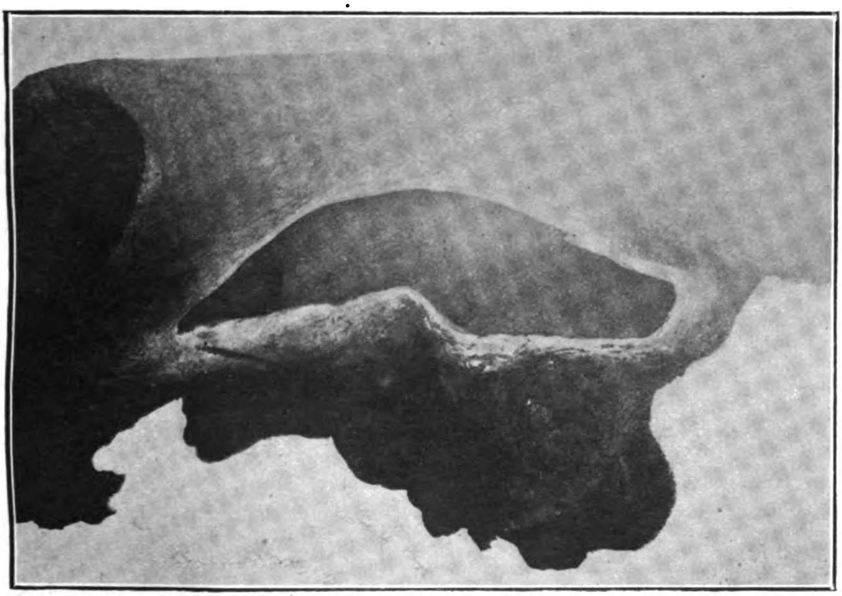

FIG. 3.—Occiput of *Bos gaurus.*

an ancient oriental race now represented in Asia by, amongst others, a Syrian breed in the act of losing its horns.

3. That some of the modern horned breeds (as, for example, some Cadzow cattle), like certain horned breeds in the possession of the Roman auxiliaries during the first century, include amongst their ancestors a race of the *Bos acutifrons* type, to which the gaur and the banting may also be related.

ORIGIN OF DOMESTIC HORSES.

During the later part of the nineteenth century it was generally taken for granted (1) that "the seven or eight species of Equidæ now existing are all descended from an ancestor of a dun color more

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or less striped;"[1] (2) that the common ancestor of the living horses, asses, and zebras was connected by a single line of descent with the four-toed "fossil" horses of the Eocene period; (3) that the domestic horses are descended from a Pleistocene species characterized by large molars with a long anterior internal pillar, a large, heavy head, and coarse limbs; (4) that in various parts of Europe and Asia domestic races increased in size and were improved in form, speed, and disposition as a result of artificial selection and favorable surroundings.

The naturalists who believed in the origin of domestic horses from one wild species usually took for granted that this species consisted of two more or less distinct varieties. Sanson, a distinguished French hippologist, believed that domestic breeds represented eight distinct types, some of which had descended from an African variety (*Equus caballus africanus*), while the others were derived from an Asiatic variety (*Equus caballus asiaticus*). But while in France modern horses were said to have sprung partly from an oriental and partly from an African variety of the original horse, in Germany naturalists, following Frank and Nehring, as a rule adopted the view that modern breeds are a blend of an oriental and an occidental variety, the latter represented by teeth, limb, and other bones in European diluvial deposits.

Though these views have been set forth in elaborate treatises "supported by a great parade of measurements," recent inquiries and experiments afford no evidence that a wild horse with a large head and coarse limbs ever existed in either Europe or Asia, or that there ever existed wild races having the characters ascribed to either the oriental, occidental, or African varieties mentioned by European continental naturalists. It ought perhaps to be mentioned that while most naturalists, following Cuvier, assumed that modern and prehistoric occidental races all belonged to one species, others found evidence of the existence in Europe during the Pleistocene period of numerous species. It may also be mentioned that fossil bones which undoubtedly belonged to an ass of the onager or kiang type were sometimes described as horse bones, and that a small fossil horse not unlike a modern Exmoor pony which lived in the south of England in Pleistocene times was regarded by Owen as "an ass or a zebra" and duly labeled *Asinus fossilis.*

On the Continent of Europe it seems to be still generally assumed that the domestic breeds are descended from a single species, but in England and America many naturalists now believe (1) that domestic horses have sprung from several wild species probably connected by several lines of descent with three-hoofed species of the Miocene period, and (2) that while some of the wild ancestors were adapted for living in the vicinity of forests and upland valleys, others were adapted for a steppe, plateau, or desert life.

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[1] Darwin. Animals and Plants, Vol. II p. 17.

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Though the wild horse discovered some years ago by Prejvalsky in Mongolia has neither coarse limbs nor broad hoofs, it is regarded by many as the modern representative of the fossil horse from which domestic breeds are said to have descended. This is the view adopted by Prof. Dürst in his report on the Animal Remains from the Excavations at Anau.[1]

In a paper published in 1904 on The Multiple Origin of Horses and Ponies,[2] I recognized three distinct types of horses, viz, the Prejvalsky, Celtic, and Norse types. In 1907 I pointed out that these three types might be known as the "steppe," "plateau," and "forest" types,[3] and in 1909 added the "Siwalik" type to include horses allied to *Equus sivalensis* of the Indian Pliocene deposits.[4]

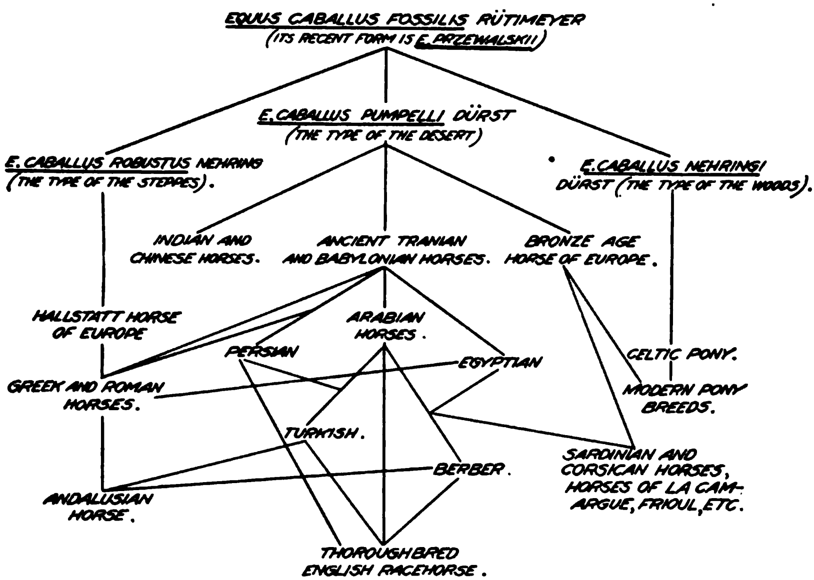

FIG. 4.—Diagram showing Dürst's view as to origin of domestic breeds of horses.

Quite independently Prof. Dürst arrived at the conclusion that modern breeds had a multiple origin and that amongst their ancestors were included "steppe," "desert," and "forest" ancestors, but he assumed that both wild and tame modern horses are all descended from a fossil species now represented by *Equus przewalskii.* Prof. Dürst's view as to the origin of the domestic breeds is graphically represented in the accompanying diagram (fig. 4).

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[1] Durst. Animal Remains from Anau. The Pumpelly Expedition of the Carnegie Institution of Washington. 1907.

[2] Ewart. The Multiple Origin of Horses and Ponies. Transactions of the Highland and Agricultural Society of Scotland. 1904.

[3] Ewart. On Skulls of Horses from the Roman Fort at Newstead. Transactions of the Royal Society of Edinburgh. Vol. XLV. Pt. III. 1907.

[4] Ewart. The possible Ancestors of Horses Living Under Domestication. Proceedings of the Royal Society. B. Vol. 81. 1909. Science, N. S., Vol. XXX, No. 763.

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Reasoning from osteological data, Dürst believes the diluvial horse of Westeregeln, Remagen, and southern Europe (*Equus caballus robustus seu germanicus* Nehring) is a descendant of *Equus stenonis* Coochi, of the Italian Pliocene, a relative of *Equus sivalensis* and *Equus namadicus* of India. I have, however, failed to find evidence of a relationship between *Equus stenonis* and Nehring's *Equus robustus*, and there is a profound difference between the teeth of *Equus namadicus* (which seems to be closely allied to the American preglacial species *Equus complicatus*) and the teeth of *Equus sivalensis*.

Equus przewalskii, Dürst says, stands as the last representative of the Tertiary and Quaternary horse *Equus stenonis* and harmonizes with the diluvial horse of Solutré. If *Equus stenonis*, as Dürst admits, resembled *Equus sivalensis*, it is difficult to believe that it is now represented by *Equus przewalskii*. The horse of Solutré in limbs and teeth resembles on the one hand typical horses of the forest type and on the other the horse of Grimaldi. The only well-preserved skull of a Pleistocene horse in existence was obtained a few years ago in the Grotto de Cavillon, Grimaldi. The conclusion arrived at after a very exhaustive study of the Grimaldi skull and teeth by Prof. Marcellin Boule is that the horse which in Pleistocene times lived in the vicinity of Mentone is most closely related to Ewart's forest type and quite different from the steppe horse, *Equus przewalskii.*[1]

The small stout horse of the ancient Germans (*Equus caballus nehringi* Dürst) is doubtless a true forest horse, but I fail to see why it should be separated from *Equus caballus robustus* Nehring, which in limbs and teeth belongs to the forest type, or why it should be regarded as the ancestor of the slender-limbed Celtic pony (*Equus agilis celticus* Ewart), which with *Equus agilis libycus* represent my plateau type.

Some years ago Prof. Fairfield Osborn pointed out there lived in America during Miocene times—ages before man reached the New World—in addition to generalized types, small three-toed horses, adapted like the modern elk and moose for a forest life, and also three-toed horses with extremely slender limbs and complex teeth highly specialized for a desert life. When experimenting with zebras I ascertained that the wild striped horses of Africa differ amongst themselves, not only in form, size, and markings, but also in their skeleton, and that they are specialized for different habitats. Some zebras (as the true Burchell zebra) are adapted for a forest life. Others (as the zebra of Shoa and Somaliland) are characterized by long powerful jaws and long hoofs, adapted for steppe-like areas,

[1] Boule. Les Grottes de Grimaldi, tome I, fas. 3. 1910.

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like the wild horse of Mongolia; the extinct quagga, once common in South Africa, was specialized for a desert life, while the zebra met with to the northeast of Lake Baringo has the face strongly bent downward on the cranium, as in sheep and other forms adapted for upland valleys.

Up to the end of last century it was generally taken for granted that in all the modern horses the face is nearly in a line with the cranium, that horses with short-pillared molars have long been extinct, and that the broad cannon (metacarpal and metatarsal) bones of Shires and Clydesdales are the product of artificial selection. Now, however, it is realized (1) that though in some modern breeds the face is short and in a line with the cranium, in others it is long and so strongly bent downward that it forms, as in the Baringo zebra, an angle of nearly 20° with the cranium; (2) that in some fossil Pleistocene horses the cannon bones are relatively as short and broad as in Shires and Clydesdales, and (3) that in some modern horses the internal pillar of the molars is as short as in the oldest true horse hitherto discovered—the *Equus sivalensis* of the Siwalik hills of northern India.

The only horse skulls from the Pleistocene deposits of Europe, sufficiently well preserved to admit of the relation of the face to the cranium being accurately determined, are those found in the grottoes of Grimaldi near Mentone, and the only well-preserved Pliocene horse skulls hitherto found in Asia belong to *Equus sivalensis* of India. But notwithstanding the absence of well preserved skulls it has been possible by making use of new methods to obtain a considerable amount of evidence in support of the view that domestic horses had a multiple origin, that they include amongst their ancestors not only varieties allied to the wild horse which still survives in Mongolia, and varieties adapted for a forest life, but also varieties specialized for ranging over boundless deserts and plateaus, and for living amongst foothills and upland valleys.

HORSES OF THE FOREST TYPE.

In a typical horse of the forest type the face is nearly in a line with the cranium, the internal pillar of the molars is at least half the length of the crown measured from before backward, and the middle metacarpal (front cannon bone) is in length from 5.5 to 5.8 times the width at the middle of the shaft.

In some of the long, low, broad-browed modern Iceland ponies the teeth and cannon bones are practically identical with fossil teeth and cannon bones found in the "elephant bed" at Brighton and at the Paleolithic settlement of Solutré, to the north of Lyons. It may hence be provisionally inferred that the horse of Solutré, which

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measured about 12 hands at the withers, and the somewhat smaller horse of the "elephant bed" at Brighton, like the modern broad-browed Iceland ponies, were characterized by a short, broad, dished face, an elklike muzzle, a short neck, low withers, and short, stout limbs ending in broad hoofs, by 6 lumbar and 18 caudal vertebræ, rounded hind quarters, and a low-set-on tail. Further, as many stout ponies of the forest type are of a yellow-dun color and have a broad dorsal band and zebralike bars on the legs, and as in some cases there are in addition faint stripes on the face, neck, withers, and trunk, and spots over the hind quarters, it may be assumed that the remote ancestor of the forest horse was of a yellow-dun or fawn color, and nearly as richly, though not so conspicuously, striped as some of the modern zebras.

More or less typical horses of the forest or *robustus* type are still met with in Korea, Tibet, Russia, Norway, the western islands and highlands of Scotland, and in Iceland.

In post-glacial times there were apparently three varieties of the forest type in Europe, viz, (1) a variety with an elklike muzzle, (2) a variety with a straight profile, and (3) a variety with a dished tapering face such as one often sees in Shetland ponies. The first variety, represented by the horse of Solutré, was a member of the true forest fauna; the second, represented by Prof. Boule's horse of Grimaldi, seems to have been adapted for sparsely wooded upland areas; the third, represented by the large diluvial horse of Germany, was probably specialized for low-lying bogs and marshes. All three varieties were adapted for moving over soft ground, browsing on shrubs and trees as they wandered along the banks of lakes and rivers, and in times of danger covering short distances at sufficient speed to have a chance of escaping from their habitual enemies. All the modern domestic races and breeds characterized by a short, broad, dished face, short, coarse limbs, upright pasterns, and wide hoofs, by rounded hind quarters and a low-set-on, full, wavy tail, by a heavy mane and a broad dorsal band, probably include horses of the forest type amongst their ancestors. Some of the small horses (from 11 to 12.2 hands) in the Roman military fort at Newstead, near Melrose, were nearly pure members of the forest type; some of the modern long, low Shetland ponies probably differ but little from the small horse of the "elephant bed" at Brighton; and the long, low, broad-browed, stout Iceland ponies, which often carry the head in a nearly horizontal position, probably closely resemble the small horse of Solutré.

Moreover, the handsome but far from fleet broad-browed white Arabs with a full mane and tail owe much of their beauty to forest ancestors, and it is from the same source that many of the fjord horses of Norway have inherited their more striking characteristics.

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The horse of Ardenne has long been regarded as a modified descendant of the horse of Solutré, and Prof. Boule evidently thinks the French Percheron has inherited some of its traits from ancestors allied to the straight-faced horse of Grimaldi. Of heavy British breeds the Suffolk horse approaches nearest to the forest type.

To what extent Shires and Clydesdales and large breeds of Continental Europe are indebted to the diluvial horse of Germany it is impossible to say, but it is highly probable that all modern dray horses with round hind quarters, though often differing in many respects from the horse of Solutré, have inherited their upright shoulders, large cannon bones, and low-set-on tail from forest ancestors. It is hardly necessary to say that a horse adapted for swamps and marshes, which (if one may judge by its modern representatives) was neither fleet nor courageous, is not likely to have contributed much to the making of the English Thoroughbred.

Though nothing is known about the remote ancestors of horses of the forest type, it may be mentioned that toward the close of the Miocene period a large three-toed forest horse (probably allied to the American forest horse Hypohippus) occurred in the north of China. It is possible that this three-toed Chinese forest horse reached Asia from America by land bridges in the vicinity of Bering Straits, and was gradually modified to form the coarse-limbed horses which in Pliocene times frequented the valley of the Arno and other parts of Italy. That the second and fourth toes long persisted in the ancestral forest horses is suggested by the extra hoofs still occasionally found in foals of Shire and other coarse-limbed breeds.

HORSES OF THE PLATEAU TYPE.

In Miocene times Neohipparion, a three-toed horse highly specialized for a desert life, made its appearance in America. Evidence of high specialization in Neohipparion we have in the complex teeth, the small size of the second and fourth digits, and the fineness of the middle cannon bones. That this three-toed Miocene horse, though only 9 or 10 hands high, was extremely fleet-footed and surpassed "the most highly bred modern race horse in its speed mechanism" is especially suggested by the metatarsals (hind cannon bones). In the finest desert Arab the metatarsals are rarely three-fourths the length of the femur and decidedly shorter than the humerus; in Neohipparion the metatarsals were as long as the femur and very decidedly longer than the humerus. Three-toed horses of the Neohipparion type eventually became extinct, and there is no evidence that an attempt was ever subsequently made to produce a true horse "with as fine limbs as in Neohipparion and otherwise proportioned like a Virginian deer." Nevertheless, a horse of the one-toed or modern type fairly well adapted for a desert life was eventually evolved.

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About the beginning of the Pliocene period there lived in the north of China not only very large browsing three-toed forest horses, but also horses adapted for a steppe or plateau life. One of these, apparently allied to Pliohippus of America on the one hand and on the other to *Equus sivalensis* of India, was characterized by short-pillared molars. Horses with small-pillared teeth and slender limbs occurred in Italy and in France toward the close of the Pliocene period, and in Pleistocene times varieties of a like species ranged from Algiers to the south of England. The Italian slender-limbed race was regarded as a variety of *Equus stenonis;* one of the African races was named *Equus asinus atlanticus;* one of the French races, believed to be allied to zebras of the Burchell type, was for a time known as *Equus ligeris*, and the small race which inhabited the south of England was regarded by Owen as "an ass or a quagga" and named *Asinus fossilis.*

Recently the remains of a horse, Arablike in form, which measured between 12 and 13 hands at the withers, were found in the Roman fort at Newstead. This Newstead horse had molars like those from the Oreston fissure near Plymouth described by Owen, and cannon bones of the same type as those of the small fossil horse of Kents Hole, near Torquay—in the last premolar and first molar the internal pillar is only about one-third the length of the crown instead of one-half as in a forest horse, and the metacarpal is in length seven and a half times the width at the middle of the shaft instead of five and a half as in typical forest horses.

Further, in the Newstead fine-limbed pony the face forms an angle of 8° with the cranium, and is so fine and narrow that the frontal index (width of face multiplied by 100 and divided by the length) is only 54, while in a forest pony the face, which is on a line with the cranium, is so broad and short that the frontal index is usually over 60.

Some of the Exmoor, Hebridean, and Iceland ponies of the Celtic variety, and some Mexican ponies of the Libyan variety of the plateau type, in their skulls, teeth, and limbs very closely agree with the Newstead pony, which has molars like the small Oreston horse (Owen's *Asinus fossilis*) and cannon bones like the fine-limbed horse of Kents Cave. It may hence be assumed that the small horses which in Pleistocene times ranged from Algiers to the south of England resembled modern Mexican ponies of the Libyan variety or British ponies of the Celtic variety.

Ponies of the Celtic type which are met with all over northwestern Europe are characterized by the absence of the hind chestnuts and all four ergots (fetlock callosities), by a large cranium and a fine, narrow, only slightly deflected face, by small pillared molars, large eyes and small ears, by a long neck, fine limbs, long pasterns and small

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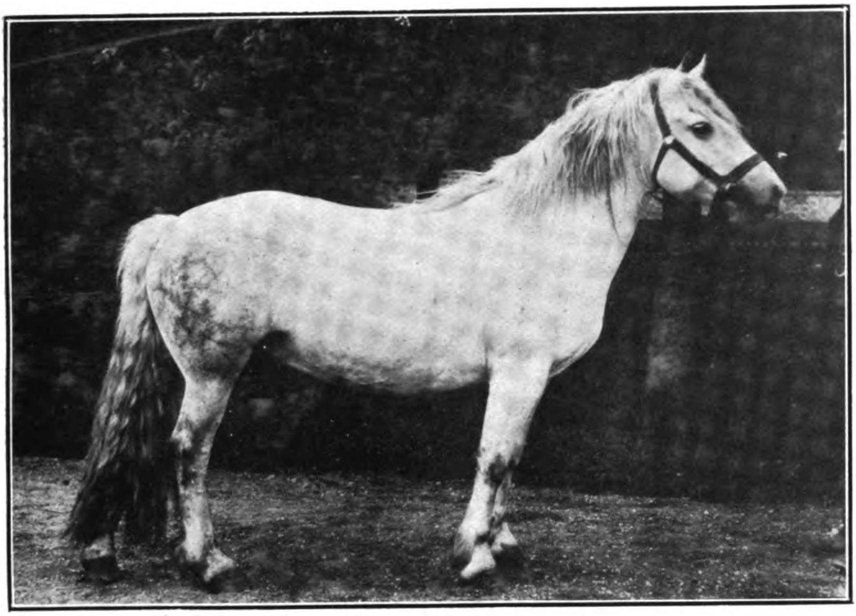

FIG. 1.—HIGHLAND PONY OF THE FOREST TYPE.

FIG. 2.—FACE OF A FOREST HORSE, WITH ZEBRA-LIKE MARKINGS.

FIG. 3.—HEAD OF A CART HORSE, WITH THE FACE DEFLECTED AS IN THE SIWALIK TYPE AND A PRONOUNCED "ROMAN" NOSE AS IN THE STEPPE TYPE.

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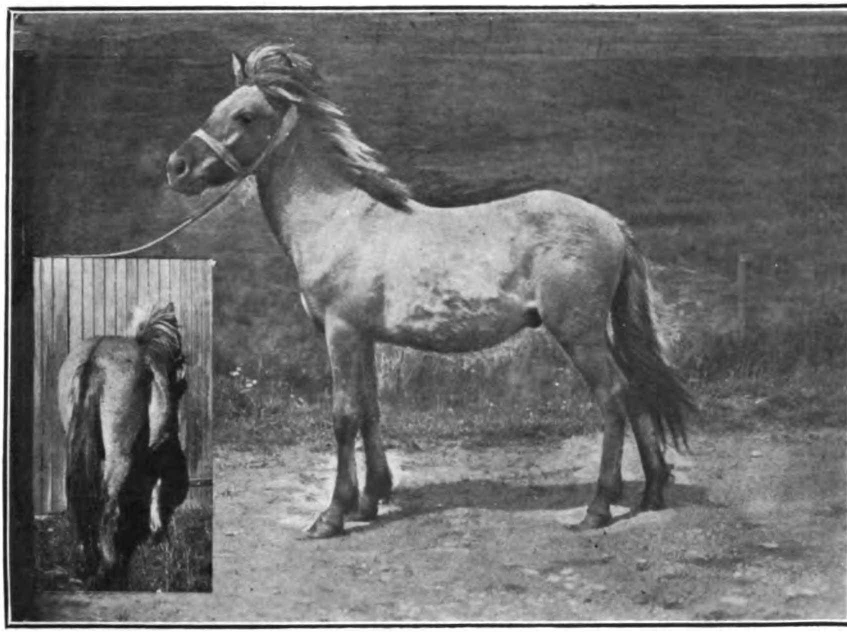

FIG. 1.—TWO-YEAR-OLD PONY OF THE PLATEAU TYPE.

FIG. 2.—YELLOW-DUN ICELAND PONY OF THE CELTIC TYPE, WITH MONGOLIAN PONY IN BACKGROUND.

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FIG. 1.—SKULL OF A HORSE OF THE FOREST TYPE.

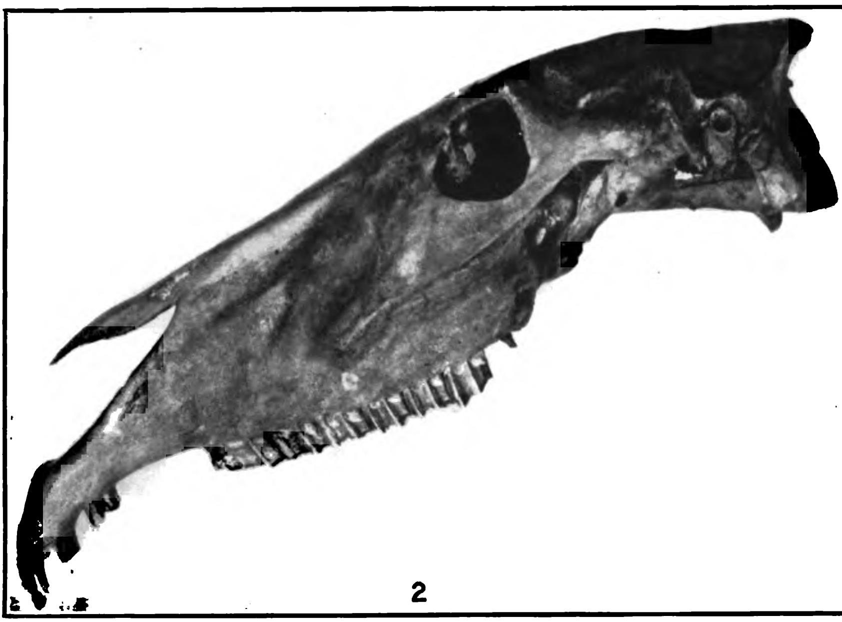

FIG. 2.—SKULL OF A HORSE FROM A ROMAN FORT IN THE SOUTH OF SCOTLAND.

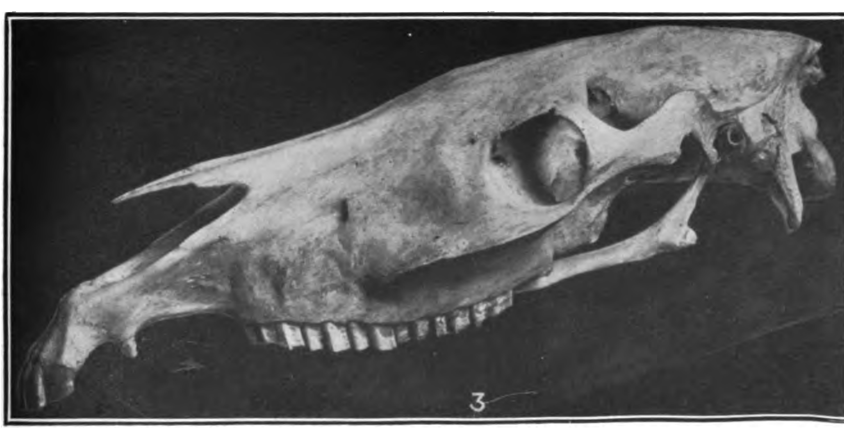

FIG. 3.—SKULL OF PERSIMMON, THE FAMOUS RACE HORSE OWNED BY THE LATE KING EDWARD VII OF ENGLAND.

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hoofs, by having 5 lumbar and 16 caudal vertebræ, and by a "tail lock" and the almost complete absence of stripes.

By crossing Barra-Iceland mares with a stallion in which five breeds (Arab, Shetland, Hackney, Welsh, and Connemara) are represented I have obtained a number of yellow-dun colts which in form and color as well as in mane and tail differ from all their known ancestors. It is believed that in one of these colts (characterized by the absence of hind chestnuts, by a very narrow dorsal band, a somewhat mule-like tail, and the instincts of a wild animal) there has been reproduced a horse resembling the wild, slender-limbed race which in prehistoric times lived in the south of England.

By blending Arabs and Mexican ponies crosses were obtained some years ago in Mexico which probably as accurately reproduce the slender-limbed race preserved in the Pleistocene deposits of Algiers.

Slight differences between the restored Oreston horse and the Mexican crosses—differences in conformation and of mane and tail—suggest that the slender-limbed Pleistocene species (*Equus agilis*) included two varieties, a northern (*Equus agilis celticus*) and a southern (*Equus agilis libycus*). In all the Prejvalsky horses hitherto examined, as in typical forest horses, there exists a complete set of well-developed callosities, four chestnuts and four ergots, but in crosses between well-bred Celtic pony mares and Prejvalsky and forest stallions, as in mules and zebra hybrids, the hind chestnuts are either small or absent. Hence it may be assumed that horses and ponies with the hind chestnuts small or absent include members of the plateau type amongst their ancestors.

Up to a few years ago there existed in Norway a small ancient race (the "Udganger" or Nordlands race), which, though dwarfed by uncongenial surroundings, was "almost purely Celtic in its characters."

Small but normally developed yellow-dun ponies of the Udganger type, with only two of the eight callosities present in Prejvalsky's horse, and with a typical tail lock, still occur in the north of Iceland. A small Udganger mare from Iceland produced to a Highland stallion of the forest type a pony with all the points of the modern Norse fjordhest. This suggests that the fjord horse of Norway (in which the hind chestnuts and ergots are small or absent) is a blend of the forest and Celtic types. The same Udganger mare crossed with a small prepotent Hebridean stallion of the forest type produced a long, low, hollow-faced pony with round quarters and a low-set-on tail, but without hind chestnuts; that is, a pony having the more striking characteristics of the modern stout Shetland strain. Hence it may be assumed that there is Celtic blood in even the big-boned, broad-browed ponies of Shetland. That fine-limbed Shetland ponies are saturated with Celtic blood has been proved by the examination

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of the skeleton of a typical pony of the riding type. Though in this pony, owing to the dwarfing influence of the environment, the cannon bones are relatively shorter than in the Kents Cave horse, the pillars of the molars are as short as in the small horse of Oreston.

Evidence of Celtic blood is also found in Hebridean, Achill Island, Welsh, Exmoor, and other British ponies, and in Russian, French, and other continental European ponies, while evidence of Libyan blood is found in the ponies of Jamaica, Cuba, and Mexico.

The Libyan variety of the plateau type has specially contributed to the making of the finer strains of Barbs and Arabs and, through Barbs and Arabs, to numerous oriental and occidental breeds, including the English race horse.

As in many Shetland ponies there is little evidence of Celtic blood, so in many modern Thoroughbreds there is little evidence of Libyan blood. But even when, as in the famous race horse Persimmon, there is a prominence between the orbits, a low frontal index, considerable deflection of the face on the cranium, and relatively broad cannon bones, it may be taken for granted that horses of the Libyan type are included amongst the ancestors.

Clydesdales, Shires, and other heavy breeds may also include plateau horses amongst their progenitors, but evidence of either Celtic or Libyan blood is now conspicuous by its absence—the fine head, slender limbs, and other points of a fleet desert race, if they ever existed, have been eliminated by artificial selection.

HORSES OF THE STEPPE TYPE.

During the cold phases of the glacial epoch the musk ox, reindeer, and other arctic species ranged southward to within a short distance of the Mediterranean, but during the warm interglacial periods central Europe was mainly occupied by a forest fauna. When, however, steppe conditions prevailed the fauna resembled that now met with on the steppes beyond the Volga. On the steppelike tracts which existed in Europe in Pleistocene times in addition to small steppe mammals there were large herds of wild horses. From the teeth and limb bones found along with the remains of typical steppe species, but especially from the engravings and drawings made by the artist hunters of the early Stone age, it is evident that the horse which inhabited the European steppes in prehistoric times closely resembled the wild horse (*Equus przewalskii*) which still survives in Mongolia.

Some of the horses imported from the great Gobi Desert of Mongolia look as if they belonged to a pure wild race, but others are evidently hybrids between wild stallions and escaped Mongolian mares—they at least closely agree with the hybrids bred in England by crossing Mongolian and other mares with a Prejvalsky stallion.

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The Mongolian wild horse measures about 13 hands and is of a yellow-dun color; the muzzle is light as in Exmoor ponies, but there are usually neither distinct leg bars nor stripes across the withers, and the dorsal band is narrow and inconspicuous. A typical steppe horse is especially characterized by an upright mane and a mulelike tail, by a long, narrow face, flat between but distinctly convex (Roman-nosed) below the level of the orbits, by powerful jaws armed with relatively large, long-pillared molars, by a short neck, and a short, strong back, by having the root of the tail in a line with a nearly level croup, and by fine, clean limbs, narrow hoofs, and a complete set of callosities (four chestnuts and four ergots). Some of the Prejvalsky hybrids I have bred are quite tractable, but it is doubtful if a pure wild steppe horse has ever been domesticated.

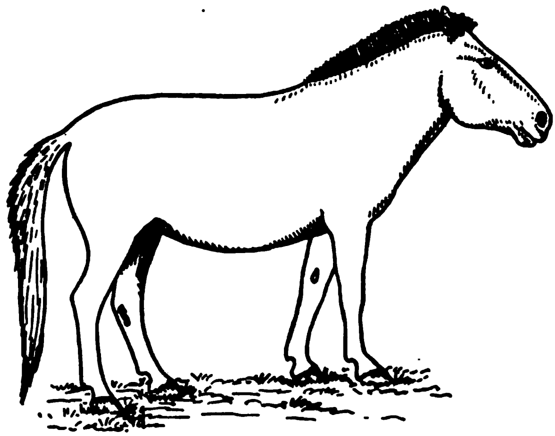

FIG. 5.—Outline from photograph of a wild mare (*Equus przewalskii*) imported from Mongolia.

There is nothing remarkable about the neigh or gait of the wild horse, but it differs from horses of the forest and plateau type in the ease with which it clears obstacles when alarmed or when in search of fresh pastures.

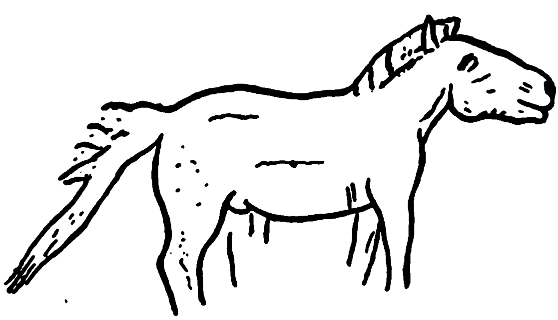

FIG. 6.—Drawing of a paleolithic age, which evidently represents a large-headed horse of the Prejvalsky or steppe type. The paleolithic artist has exaggerated the roughened condition of the hair at the root of the tail.

Poliakoff, who gave the first account of Prejvalsky's horse, for some inexplicable reason stated that the legs are remarkable for their thickness. As a matter of fact, though the legs are coarser than in Arabs, they are nearly as fine as in modern race horses.

Perhaps because the legs were described as coarse, Prejvalsky's horse is still, as already said, regarded by some zoologists as the modern representative of *Equus fossilis*, long supposed to be the

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common ancestor of all the horses living under domestication. There is, however, very little indication of steppe blood in the English Thoroughbred, and the view that an extinct species now represented by the wild horse of Mongolia has contributed to the making of race horses receives little or no support from hybrids between *Equus przewalskii* and well-bred modern ponies.

In modern Shires and Clydesdales the face is usually long and convex—very different from the short, concave (dished) face of a typical forest horse. As the characteristic long arched face so common in modern heavy breeds has obviously not been inherited from ancestors of the forest or plateau types, and as there is no reason to believe that *Equus sivalensis* had a Roman nose, the probability is that Clydesdales and other Roman-nosed heavy breeds are in part descended from steppe ancestors now represented by *Equus przewalskii.*

There is little or no evidence that the Norwegian fjord horse, or that Shetland, Iceland, and other ponies with the fine head, are in part descended from steppe ancestors, but some Russian ponies in their mane and tail resemble Prejvalsky hybrids. This is especially true of the semiwild tarpans, once common on the Russian steppes—in all probability the tarpans resembled Prejvalsky hybrids because they were descendants of crosses between a steppe race and domestic horses which had run wild. Further inquiries may show that Roman-nosed light as well as heavy breeds include steppe horses amongst their ancestors, and especially that Irish hunters are mainly indebted to a race of the Prejvalsky type for their remarkable leaping powers.

HORSES OF THE SIWALIK TYPE.

During the later part of the Pliocene period (i. e., according to a recent estimate about 500,000 years ago) there suddenly appeared amongst the foothills of the Himalayas a horse quite 15 hands high, in build not unlike a modern racehorse. In course of time remains of this large and ancient member of the equine family were found in the Siwalik Hills of India, and appropriately named *Equus sivalensis.* This species, which in late Pliocene times made its appearance in the north of India along with the camel, has always attracted attention for several reasons. To begin with, the Siwalik horse is the oldest known true horse, the oldest member of the genus *Equus*—the genus which includes asses and zebras as well as wild and tame modern horses. In the next place, it differs considerably from the supposed remote ancestor of the true horses, that is, from Pliohippus, a small (12 hands) Lower Pliocene species with simple teeth and with perhaps complete but small digits at the ends of at least the front splint (metacarpal) bones. Further, *Equus sivalensis* (or its

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less specialized relative *Equus stenonis* of Europe) has interested zoologists because it has probably played a more important part in the making of the English racehorse than any other wild species. Whether *Equus sivalensis* was evolved in Asia, or came perfect in all its parts from America by a land bridge which spanned the gap now known as Bering Strait, has still to be determined.

The large horse which in Pliocene times ranged amongst the foothills of the Himalayas when the Siwalik Hills were in the making, had, as already mentioned, the face so strongly deflected that it formed an angle of about 20 degrees with the cranium. Partly because the face is bent downward as in sheep, and partly because of the presence of air sinuses, the Siwalik horse was characterized by a marked prominence between the eyes—a projection quite distinct from the nasal prominence below the level of the eyes so often met with in Shires and Clydesdales. Further, in the Siwalik horse the internal pillar of the last premolar and first molar is small, as in the plateau type, and the first premolar (wolf tooth) is well developed. Until recently it has been taken for granted that the grinding surface of the internal pillar of the last premolar and all three molars is invariably long in modern breeds, and that in large as well as in small races the face is nearly in a line with the cranium. But skulls from the Roman fort at Newstead clearly prove that, up to at least the first century, there were horses with the internal pillar small in both premolars and molars, and with the face nearly as deflected as in sheep and other upland forms adapted for grazing on short herbage. The discovery of short-pillared teeth and a deflected face in first-century horses led to the discovery that in some present-day Arabs and Thoroughbreds, as in some of the horses of the Kirghiz steppes, the face is decidedly bent downward on the cranium and that the internal pillar of the last premolar and first molar is nearly as short as in *Equus sivalensis*. In the Siwalik type the face is not only deflected; it is broad, as in the forest type, and long, as in the steppe type, with the result that the frontal index is nearly the same as in horses of the plateau type.

An indication of the height and conformation in horses can generally be gained from the cannon (metacarpal and metatarsal) bones. For example, when the length of the metacarpal is 250 mm. the height at the withers is about 15 hands; when 265 mm. the height is about 16 hands. Further, when the length of the metacarpals is 7 to 7.5 times the width it may be taken for granted that they belong to a fine-limbed race. In *Equus sivalensis* the metacarpals sometimes measured 252 mm.; and the length was 7 times the width. As in Persimmon and other large-boned Thoroughbreds the length is only 7.2 times the width, it may be inferred that some of the horses which lived to the south of the Himalayas in Pliocene times belonged to a slender-limbed race which measured at least 15 hands

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at the withers. In long-legged browsing (forest) horses, the neck, as in browsing ruminants, is short, but it is essential in long-limbed grazing horses that either the neck or the face should be long. When the head is small, as in plateau horses, a long neck does not necessitate high withers, but when the long neck ends in a large, heavy head with long jaws armed with large teeth, high withers are inevitable.

It is hence extremely probable that *Equus sivalensis* had high withers. For some reason or other high withers are usually accompanied by a high-set-on tail.

Bearing all these facts in mind, it may be provisionally assumed that *Equus silvalensis* of India was a tall, broad-browed horse characterized by a long, tapering deflected face and an interorbital prominence, a long neck, high withers, and a high-set-on tail. As Arabs and Indian horses with a prominence between the eyes are usually fleet but of an uncertain temper, it is extremely probable that *Equus sivalensis* belonged to a fleet race characterized by an indomitable disposition.

There is not yet sufficient material available to admit of definite conclusions being arrived at as to which modern breeds are most intimately related to horses of the Siwalik type. Further inquiries and experiments, and a more complete knowledge of the phases through which a horse passes during the later stages of its development, may support the view that light as well as heavy horses characterized by long pointed ears and a prominence between the eyes, by a long deflected face, high withers, and a high-set-on tail include horses of the Siwalik type amongst their ancestors.

Though Thoroughbreds and Arabs with a fine head are probably mainly descended from the Libyan variety of the plateau type, Thoroughbreds built on the lines of Stockwell and Persimmon are probably more intimately related to *Equus sivalensis* than to Prof. Ridgeway's "fine bay horse" (*Equus caballus libycus*) of north Africa.

THE LAWS OF BREEDING.

From what has been previously said in this article it follows that the breeder, instead of troubling about so-called infection, maternal impressions, and the transmission of acquired somatic modifications, should concentrate his attention on the environment and the origin, history, and pedigree of his breeding stock. He should bear in mind that domestic varieties should as a rule be more, not less, prolific than varieties living in a wild state—that domestic swine, for example, should bring forth twice as many young as wild pigs, while domestic fowls should lay 10 or 12 times the number of eggs laid by the wild fowl *Gallus bankiva*.

If any members of his flocks and herds become sterile he should endeavor to determine the cause, to find out if the sterility is due to

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overfeeding, to insufficient or unsuitable food, to inbreeding, to the exhaustion that sometimes follows from the rearing of crosses or hybrids, or to the reproductive system being upset by some change in the surroundings. If the offspring obtained are below the standard expected he should endeavor to ascertain whether this is due to his having failed to realize that the breed he is operating with consists of several perfectly distinct types which revert when crossed.

To be in a position to carry on his work economically and intelligently the breeder should further have a working acquaintance with the laws of heredity. It no longer suffices to assume, as was done by breeders a generation ago, that on an average each parent contributes one-half, each grandparent one-quarter, and so on, of the total heritage. He must know about Galton's law of ancestral inheritance, about the work of Gregor Mendel and his followers, and realize what is implied by the conclusions arrived at as to the continuity of the germ plasm.

According to Galton—

> The two parents between them contribute on an average one-half of each inherited faculty, each of them contributing one-quarter of it. The four grandparents contribute between them one-quarter, or each of them one-sixteenth, and so on, the sum of the series $\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\frac{1}{16}+$ —— being equal to 1 as it should be.

It need hardly be stated that the prepotencies or subprepotencies of particular ancestors in any given pedigree are eliminated by a law that deals only with average contributions, and that the varying prepotencies of sex in respect to different qualities are also eliminated. According to this law the average contributions made by parents, grandparents, etc., are definite and diminish in a precise ratio according to the remoteness of the ancestors. Though Galton did not mean his law to apply to individual cases, the breeder should bear in mind that it may be approximately true of a considerable number of cases in each generation.

While, according to Galton's law, each parent contributes one-quarter of each inherited faculty (which implies that in every germ cell both parents are represented), according to Mendel's law the actual or immediate parents are not necessarily represented in their germ cells. The bearing of Mendel's law on breeding problems will be best realized by an example. Let us suppose the breeder wishes to know the color of the calves which red-roan Shorthorn heifers will produce to a red-roan Shorthorn bull. If each parent contributes half the characters, as breeders were wont to assume, all the calves would be red roans like their parents. If, as Galton's law teaches, the two parents contribute one-half and the two grandparents contribute one-quarter (assuming the heifers are the descendants of a bull belonging to a red strain and of cows belonging to a white strain) at least 75 per cent of the offspring of the heifers

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would be red roans. But as the great-grandparents and great-great-grandparents were also members of red and white strains, the probability is that over 90 per cent of the calves would be red roans, assuming Galton's law held in this case.

If instead of seeking guidance from Galton's law the breeder turned to Mendel's law, a very different estimate would be obtained as to the color of the expected calves. In each immature germ cell of the red-roan bull both parents (red as well as white) are represented, but in each of the mature germ cells, according to Mendelians, only one of the parents is represented—that is, 50 per cent of the germ cells, on an average, have the composition of the germ cells of the red sire; the remainder in composition agree with the germ cells of the white dam. Likewise in each immature germ cell of the roan heifers both the red and white parents are represented (in other words, the immature ova of the heifers are a blend of germ plasm derived from the red sire and the white dam), but, according to Mendelians, during maturation each immature egg would discharge either the germ plasm derived from the red sire or the germ plasm derived from the white dam, with the result that about 50 per cent of the germ cells produced are practically identical in composition with the germ cells of the red sire, the remainder being practically identical with the ova of the white dam. If both the roan heifers and the roan bull have two kinds of gametes—50 per cent like the gametes of pure red Shorthorns and 50 per cent like those of pure white Shorthorns—the chances are that 50 per cent of the expected calves would be roan, 25 per cent white, and 25 per cent red.

But in addition to insisting on segregation and gametic purity, Mendelians point out that all the hybrids or crosses often in appearance resemble one (the dominant) parent and that one or more of the characters of one breed may replace, or be replaced by, alternative characters in another breed—that, in fact, every organism consists of a certain number of "unit" characters which are transmitted pure or exchanged for their alternative characters.

While in some cases one breed or strain proves dominant and the other recessive, in other cases the crossing of two pure breeds or strains results in offspring (hybrids) intermediate in some points, in others like the male or the female, while in still others they take after a remote ancestor.

EXPERIMENTS IN CROSSING DISTINCT TYPES.

Some of the many possible results obtained by crossing distinct types are illustrated by the following experiments:

A Mexican dog of the Chihuahua race was crossed with a pedigree female West Highland terrier. (See Pl. XII, fig. 1.) The Mexican

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FIG. 1.—THE MEXICAN (CHIHUAHUA) DOG CHICO AND THE WEST HIGHLAND TERRIER BINA.

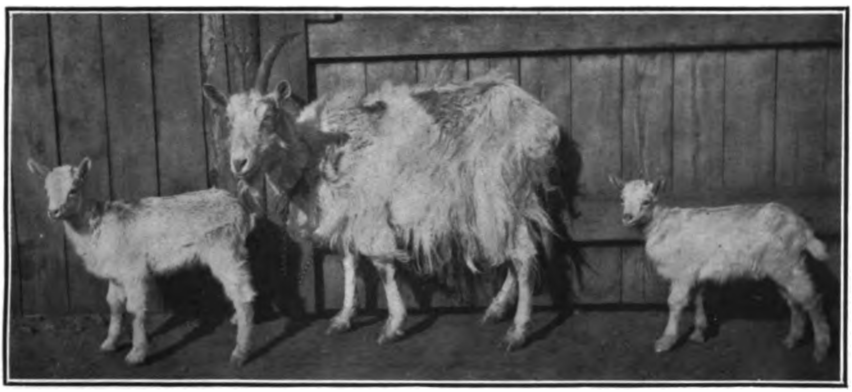

FIG. 2.—THE GOAT JOAN I AND HER KIDS.

FIG. 3.—DARBY I, THE MALE USED IN THE GOAT INBREEDING EXPERIMENTS.

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dog Chico weighs 7 pounds, is white with the exception of the ears and eyelids, which are fawn-colored; the hair on the shoulder measures from 8 to 10 millimeters. Chico is characterized by a short, fine face, a globular cranium, very large erect ears, a well-set-on flat tail and whippet-like feet armed with long, sharp claws. Though small, he is extremely active, has great endurance, and never hesitates to attack dogs many times his own size if they intrude on his preserves. When indoors he almost invariably burrows under a rug or quilt and remains quiescent for hours at a time. The hunting instinct is entirely absent.

The West Highland terrier bitch Bina is of a yellow or straw color, and the hair on the shoulder measures from 30 to 40 millimeters. Bina has a long face, the forehead is nearly flat, and the ears, though usually carried erect, are smaller than in the Mexican; the tail is long but not flattened, the legs are short and broad, and the toes short and of the true terrier type. In disposition Bina is decidedly timid, but the hunting instinct is strongly developed; she never burrows under rugs or quilts when indoors.

The offspring of Chico and Bina (one male and three females) in color closely resemble their dam, but in form and length of hair they are nearly intermediate. The dog and one of the bitches have a beautifully modeled foxlike head.

The Mexican-Highland crosses, although having the color of their decidedly domesticated dam, have from the first behaved like wild animals, and with one exception have been more difficult to tame than young wolves or foxes. Like the crossed mice, they from the first have strongly resented being handled. Each of the four is more or less devoted to one person, but three of them are still so wild that unless surprised in a corner from which there is no escape their capture is impossible. (Japanese "waltzing" mice, like tame white mice, are easily handled, but their hybrids behave like wild mice and have the color of wild mice—the crossing has apparently restored the wild ancestor.)

One of the three hybrid bitches was mated with her sire, with the result that she produced four pups, two nearly white like the Mexican ancestor (sire and grandsire), one slightly lighter and one somewhat darker than the hybrid dam.

Of the two light pups one is surprisingly like the sire in form, habits, disposition, and markings, the other in form approaches a Highland terrier. Of the two dark pups one resembles in form the hybrid dam, the other, the darker (fawn-colored) one, in the head, limbs, and tail takes after the sire.

A possible result of crossing the Chihuahua dog Chico with his hybrid daughter out of a West Highland terrier would be a litter consisting of an equal number of pure Chihuahuas and of hybrids

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resembling their dam. A result of this kind is possible because it is conceivable that during the maturation of the germ cells of the hybrid the germ plasm inherited from the Mexican sire might be completely segregated from the germ plasm inherited from the West Highland dam. If in half the ova matured the germ plasm of the Mexican ancestor was discharged during the reducing division, and the germ plasm of the West Highland ancestor was discharged from the other half of the ova the result would be a number of ripe ova bearing the Mexican characters only and a corresponding number of ripe ova bearing Highland characters only. These ova when fertilized by sperms of the Mexican race should yield an equal number of pure Mexican terriers and of Mexican-Highland terrier hybrids.

In breeds of mammals derived from two or more wild types or formed by blending several varieties or strains such a simple result can hardly be expected. Nevertheless the pup out of the Mexican-Highland bitch, which in form and color resembled the sire, may very well have been developed from two pure gametes of the Mexican type—may, in fact, be an instance of pure line breeding such as occurs in plants. That this pup (now approaching maturity) was developed from an ovum as purely Mexican in composition as the sperm by which it was fertilized is suggested not only by the color and form, but by its every movement and attitude, by its precocity and alertness, and also by its small size. Apparently the gametes so closely resembled each other in composition that the development was accelerated, but, owing to the absence of the vigor cross-fertilization brings, the growth has been arrested.

This experiment furnishes a beautiful instance of segregation, and demonstrates that characters may be transferred from one breed to another. In the reddish-brown pup we have a Highland terrier color combined with the conformation of a Mexican terrier. In the head and ears, as in the limbs and tail, this pup closely resembles his sire Chico, but in his behavior he closely agrees with a Highland terrier cousin. Though the color of the coat has been inherited from a Highland ancestor, the hair in structure and length differs but little from that of the sire. It is of course impossible to say how, or when, the exchange of "unit" characters takes place, but presumably it occurs during a phase of the maturation of the germ cells when the chromosomes derived from the male parent come into intimate relation with the corresponding chromosomes derived from the female parent.

As the light tan-colored pup is the grandson as well as the son of the imported Mexican Chico, he is decidedly inbred, theoretically as inbred as his more precocious but smaller and more high-strung sister, who, notwithstanding her mixed origin, is in some respects more Mexican than her sire. There is, however, no evidence of inbreeding in the male pup. He is well grown, has a beautiful coat,

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well-formed muscular limbs, and from the first he has been extremely vigorous. Under unfavorable conditions the highly sensitive white pup would probably succumb, but the stronger, more vigorous tan-colored one would have a good chance of surviving and leaving descendants. From the difference between these two pups it is evident that while one member of an inbred family may be small, sensitive, high strung, and not likely to survive under adverse circumstances, others may be well grown and characterized by unusual vigor.

LINE BREEDING.

Some breeders devote their energies to supplying pedigree stock, some to providing crosses between pure breeds, while others by means of pedigree sires aim at gradually converting a crossbred mixed herd into a more or less pure herd. Owners of purebred stock are as a rule line breeders—that is, their herds consist of animals belonging to a single line of descent. The disadvantage of line breeding is that unless judiciously carried on it may result in loss of vigor, size, and fertility.

When a new variety of wheat, of oats, or of corn makes its appearance and a strain is made from a single plant we have pure line breeding. Such a strain, though liable to be modified by the environment, breeds true from the first and is hence never a source of anxiety to the breeder. An example of a strain formed from a single plant is seen in Sherriff's Mungoswell wheat first placed in the market about 1820. In wheat as in many other plants there is self-fertilization, but except in certain parasites—as the fluke (*Distomum*) and the tapeworm (*Tænia*)—self-fertilization is rare in animals. The animal breeder must hence always make allowance for cross-fertilization, which not only implies new combinations and permutations but also more or less marked reversion.

CROSS-FERTILIZATION.

Weismann believed cross-fertilization was a cause of progressive variation, but, beyond giving a race or strain the opportunity of benefiting from useful traits which appear from time to time in one or more members of a race, cross-fertilization may be regarded as beneficial because it tends to increase the size, vigor, and fertility. That cross-fertilization increases the vigor is suggested by what occurs in the protozoa. If a single paramœcium, for instance, is isolated under suitable conditions, it may give rise by fission to a colony of 200 or 300 individuals; if the conditions are unusually favorable, 600 or 700 individuals may be formed, but, unless the members of an isolated colony descended from a single individual are reinvigorated (by conjugating with members of another isolated

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colony or with paramœcia living under natural conditions), they all eventually degenerate and die. The cells forming a multicellular animal in a sense resemble the members of a paramœcium colony. Hence it may be assumed that the cells forming one of the higher animals—the germ cells as well as the body cells—unless rejuvenated by cross-fertilization will sooner or later lose their vigor and degenerate.

Though a paramœcium when isolated may give rise to a colony by fission, and though the ova of aphides and certain other arthropods develop normally for a variable number of generations without being fertilized, and though self-fertilization occurs in certain parasites, pure line breeding, such as occurs in wheat, is practically impossible in the higher animals, in all of which reproduction is biparental. Nevertheless, when two hybrid members of the same litter are interbred and when the sire is mated with his daughter and the dam with her son, some of the offspring may be practically pure line bred while others are hybrids—hybrids, however, derived from gametes matured under nearly identical conditions.

Is there any evidence that in the higher forms, as in the protozoa, line breeding sooner or later leads to loss of vigor? It is admitted that to produce vigorous and prolific offspring there must be a certain amount of difference between the male and female elements from which they are developed, just as there must be some difference between conjugating paramœcia. Hence inbreeding, in as far as it diminishes the difference between the germ cells, is likely to diminish the vigor and fertility. But as there are at times weak members in crossbred families and often vigorous members in inbred families, it is difficult to determine whether in any given case loss of vigor is due to inbreeding.

INBREEDING.

Perhaps the best way to show that vigor and fertility are impaired by inbreeding is to cross an inbred female in the habit of having small litters of delicate young to sires of her own strain with a vigorous male of another breed. This was done in the case of an inbred long-haired Skye terrier which proved sterile with two Skyes of her own type, and had only one short-lived pup to a Skye of a slightly different type, but produced four vigorous pups to a West Highland terrier. In this case there was evidently a want of vigor in the female as well as in the male Skye terrier.

From a consideration of a number of cases it appears that sterility is sometimes due to a decrease in the supply of ripe ova, sometimes to the gametes failing to conjugate, and sometimes to want of sufficient vigor to carry the development beyond the initial stages.

There is a considerable amount of evidence in support of the view that inbreeding is not injurious; that at the most it only intensifies

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the weak points inherited from the founders of the breed or strain. On the other hand, there is experimental evidence in support of the view that sooner or later inbreeding reduces the fertility.

Darwin says the consequences of close interbreeding carried on for too long a time are, as is generally believed, loss of size, constitutional vigor, and fertility, and sometimes a tendency to malformation.[1]

There is, however, no evidence of degeneration in the descendants of the few deer originally introduced into New Zealand or of the few rabbits originally introduced into Australia and Porto Santo. In all probability systematic experiments would show that in some species close inbreeding can be practiced for many generations without apparently diminishing the vigor, while in other species close inbreeding soon leads to loss of size or vigor under one set of conditions, but is long in producing an appreciable effect if carried on under somewhat different conditions.

Weismann inbred mice for 29 generations, and Von Guaita continued the breeding for 7 more generations, with the result that the fertility was reduced about 30 per cent.

Rtzema-Bos inbred rats for 30 generations. During the first 20 generations there was little diminution in the fertility, but in the following generations there was marked decrease of size, loss of fertility, and increased mortality. Like Bakewell and Bates, Amos Cruickshank inbred freely when forming his famous strains of cattle, but realizing that a limit had been reached—that further inbreeding might prove disastrous—he forthwith took steps to rejuvenate his herd by means of intercrossing. With Weismann, Bos, and others, inbreeding neither led to disease nor to the appearance of monsters. Sir Everitt Millais, however, found that inbred dogs were sometimes deformed, and Low, in his work on the Domesticated Animals of Great Britain, refers to a race of foxhounds which "actually became monstrous and perished" and to an inbred family of hogs the members of which from inbreeding "became diminished in size—the bristles were changed into hairs, the limbs became short and feeble, the fertility was diminished, and the mothers were unable to nourish their young."[2]

I find that closely inbred bitches may require assistance during parturition and are sometimes unable to nurse their young, and that the young if they survive are extremely liable to be carried off by distemper.

But though inbreeding may soon lead to a loss of vigor and fertility in dogs and perhaps in swine, it by no means follows that in-and-in breeding speedily impairs the constitution of all mammals.

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[1] Animals and Plants under Domestication.
[2] The Penycuik Experiments, P. LI.

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By way of testing the effect of inbreeding amongst ruminants I have for some years been experimenting with goats. The results of this experiment are indicated in the accompanying diagram (fig. 7). Some of the animals are shown in Plate XII, figures 2 and 3.

The two goats selected in 1899 were believed to be unrelated, and as they were not members of pedigree strains they had presumably not suffered from close in-and-in breeding. The male was a year old and dark brown in color; the female was 2 years old and lemon and white in color. One of the kids born in 1900 was so delicate that it

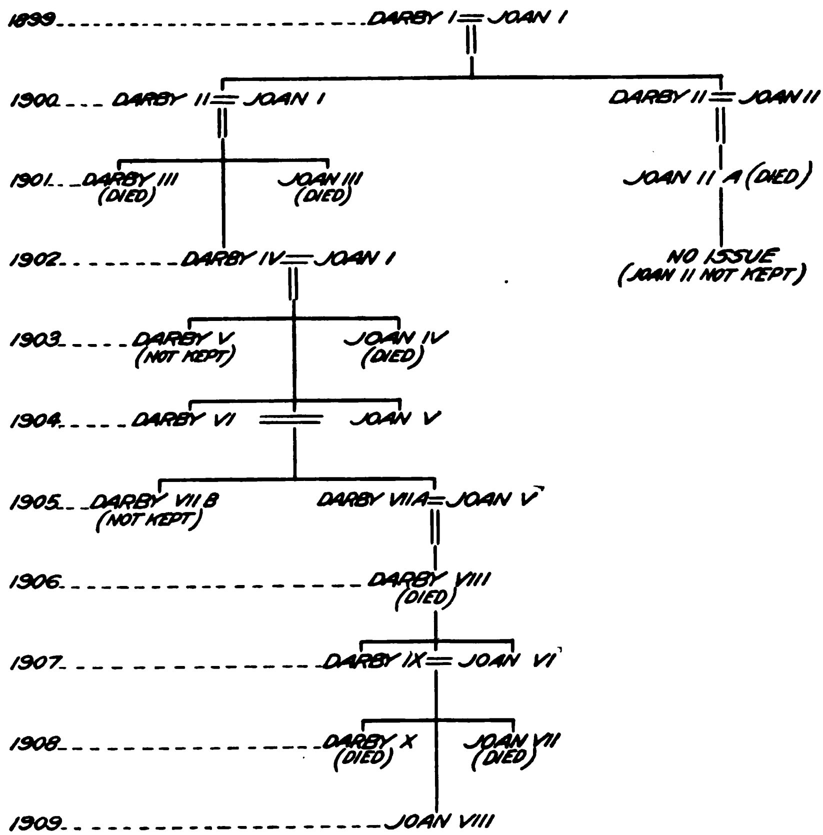

FIG. 7.—Diagram of goat in breeding experiments.

was unable to obtain nourishment unaided. For six weeks the dam was held several times a day to allow the weakling to get a share of his mother's milk. This procedure the dam strongly resented. In a wild state this delicate kid would have succumbed. When about 9 months old this kid (Darby II) was mated with his dam with the result that two kids were born in the spring of 1901. About the same time Joan II gave birth to a kid by her brother Darby II. All these kids died, but they were handicapped because they were the offspring of a sire so young and immature that in a wild state he

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would have had little chance of breeding—a sire, moreover, which under ordinary circumstances would have succumbed a few days after his birth. There was nothing remarkable about any of the 1901 kids. Strangely enough, the kid out of Joan II by her brother was more vigorous and lived longer than the kids out of Joan I by her son. Joan II–A was pure white, and like most white-skinned mammals she was extremely sensitive to cold. For some weeks she did well, but one cold damp day in March she stopped feeding, leaped into the air, and in a few minutes was dead.

In 1902 Joan I had a kid by her son Darby II which grew up into a vigorous handsome goat, in color like his dam. In 1903 the original Joan I had a pair of kids by her 1902 son, Darby IV. One of these kids (Joan IV) died young, the other, Darby V, being deficient in vigor, was given away. In 1904 Joan I had again a pair of kids by her grandson Darby IV, who by the autumn of 1903 had come to his full strength. The 1904 kids (Darby VI and Joan V) were vigorous from the first, and in form and color they closely resembled their dam.

When about 9 months old Joan V was mated with her brother Darby VI, and, notwithstanding their youth and consanguinity, they produced in 1905 two extremely vigorous male kids, which eventually grew into handsome goats, in color and form the image of their great-great-grandsire Darby I.

These 1905 kids had evidently reverted to the male with which the experiments were started in 1899. As there was no evidence of loss of vigor in the 1905 kids they would doubtless have proved from the first successful sires if mated with unrelated females. One of them, however, was bred with his mother in the autumn of 1905, with the result that only one delicate short-lived kid made its appearance in 1906. But in 1907 Joan V produced to her son Darby VII–A a pair of goats which grew well and appeared vigorous. In 1908 Joan VI produced to her brother a pair of kids which lived only a few hours. In 1909 Joan VI had a female kid by her brother Darby IX which, like the kids of 1908, was obviously deficient in vigor. A few hours after birth I noticed that the tarsal bones were so loosely connected that the part of the leg below the hock could be bent backward onto the hip. But the ligaments soon contracted, and the kid being able to suck eventually developed into a fairly presentable animal nearly as large as her dam but more highly strung and decidedly finer in the bone and in the coat.

The condition of the 1909 kid made it evident that further inbreeding would not be justified. Accordingly in 1909 Joan VII was put to an unrelated male, with the result that she had in 1910 an extremely vigorous female kid. Joan VIII having been put to an unrelated male in the autumn of 1910 is expected to have offspring in 1911.

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The death rate in this experiment has been very heavy, but chiefly, I think, because the males were allowed to breed before they were a year old. Had a pair of goats been turned out on a small island and left unmolested the result would have been very different, probably not unlike what happened when a female rabbit and her young were set free on Porto Santo. For some time the death rate would probably have been high, but owing to reversions such as occurred with the goats in 1905 the vigor and fertility under favorable conditions would have been maintained.

When the whole subject of inbreeding is considered it may be said (1) that in the case of wild animals living under ordinary but not too favorable conditions inbreeding, owing to the merciless elimination of the unfit, is not likely to prove injurious; (2) that in the case of domestic animals inbreeding carried too far may lead to the destruction of the race. This is not only because it must sooner or later result in diminished vigor and fertility, but especially because it intensifies the bad points as well as the good.

Nearly all the famous breeds and strains were formed by close inbreeding, and some breeders inbreed from first to last regardless of consequences.

A noted breeder of terriers ascribes his success to "always mating together those brothers and sisters of one litter which had the most good show points." "It would not matter," he says, "how many good points I saw in a dog bred by another person, I should never use his dog with my bitches, for if I did the variations in my stock would be hopeless."

This breeder of dogs says he is certain that if breeders of horses would adopt a like plan they would produce good animals nearly every time. This view, however, is not supported by the experiment of Lord Derby, who inbred with Papillon, dam of the Derby winner, Sir Peter. For nine generations brother and sister were mated. Von Oettingen, referring to this experiment, says the result "of the inbreeding mania of Lord Derby was a distinct fiasco." When breeding horses for show points the mating of members of the same family may lead to success, but when points are neglected and only speed is considered the breeding of brothers and sisters, in Germany and America as well as in England, has proved so complete a failure that no closely inbred Thoroughbreds are included in Goos's tables, which constitute the roll of honor for the English racehorse. During recent years there has been a great demand for St. Simon blood. Perhaps for this reason this great line seems to be on the wane. In 1909 the eight highest winners in England did not include a horse of St. Simon blood in tail male.

BREEDING "BEST TO BEST."

Breeders are now often advised to take counsel from Warfield, whose experience with cattle led him to conclude that the correct

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system or rule is "to breed the best to the best, and to avoid close affinities." Amongst wild forms the "best" means an individual well adapted for its surroundings and characterized by great vigor and fertility. With breeders the best may mean the fleetest, or the largest, or the best in form, color, or behavior, but in their eagerness for "good show points" vigor and fertility are apt to be forgotten.

In some breeds mating the best with the best may as a rule give excellent results; in others it may yield most disappointing results. It usually succeeds when the breed is pure; it is apt to fail when the breed, though regarded as pure, consists of two or more perfectly distinct types which centuries of interbreeding have failed to blend into one type. When the breed is pure, there is variation around one mean—some are a little better in one or more points and a little worse in others—but when the breed is a mixture of two or three quite distinct types, derived from as many wild ancestors, there is variation around several means and in many cases marked reversion.

In Galloway cattle we have a nearly pure yet vigorous breed in which reversion only now and again results in the appearance of rudiments of horns, white patches on the udder or thigh, or a white hind foot. In this case to breed "the best to the best" and avoid too close affinities is the best possible procedure.

But Warfield's rule is not applicable to the same extent to Shorthorns, a mixed breed formed, it is said, about two centuries ago by crossing British cows with bulls imported from Holland and Denmark. The result of mixing British and continental races has been to produce two breeds, one white, the other red, both of which breed true. As it happens, both the pure breeds and their crosses are admitted into the Shorthorn studbook. Hence the Shorthorn, so called, breed has the enormous advantage over breeds of simpler composition, because its members are constantly being rejuvenated by intercrossing.

If the black and splashed white birds which produce the so-called pure Blue Andalusian breed of fowls were included in the breed, we would have the same sort of mixture as obtains in the Shorthorn.

BREEDING TO TYPE.

Shorthorn breeders usually regulate their procedure according to whether they wish to produce pure red or pure white Shorthorns or roan hybrids, or aim at special points, such as producing beef or milk, or combining beef and milk in the same animal regardless of color. In the case of the Shorthorn the pedigree is useful in enabling the breeder to avoid too close affinities, but it is of comparatively little use for any other purpose. On the other hand, it is necessary to bear in mind that though a pure red bull appears to be of the same type as a number of pure white heifers, it by no means follows that their roan-colored hybrid offspring will in form resemble their par-

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ents. The act of crossing may lead to reversion in several different directions.

When all the members of a breed are descended from one or two types, selecting mates for the females is, as a rule, comparatively simple; but when a breed includes three or more quite distinct wild types amongst the ancestors, or is a blend of three or more ancient breeds, the selection of mates is often very difficult. In the case of the English race horse all sorts of plans have been tried, but the average of success is still very low. Sir Walter Gilbey some years ago referred to 32 yearling Thoroughbreds which sold for over $250,000. Only 2 of the 32 proved successful, and their total earnings only amounted to about $25,000.

Von Oettingen, who has made a special study of the English race horse, points out that a closely inbred horse has very little chance of winning races, and that on the other hand unless one or more noted sires occur in both pedigrees the chances are about equally small. In other words, to produce winners breeders must avoid close affinities on the one hand and the mixing up of different types on the other. What Von Oettingen means is gathered from studying the pedigree of Stockwell, in which there are what is termed five free generations.

In the case of Stockwell, Orville, Waxy, and Penelope occur amongst the ancestors of both the sire and the dam. Orville is removed from Pocahontas (his dam) by two free generations and from the Baron (his sire) by three free generations, which gives a total of five free generations.

Von Oettingen finds that most of the classical winners up to the middle of the last century had four free generations, but that during recent years most of the winners have had five free generations. But as the number of free generations increases the chances of success diminish. Apparently when there are no free generations Thoroughbreds are deficient in vigor, while when there are too many free generations they fail because speed has been lost by reversion.

The usual practice in the case of Thoroughbreds is to put the most successful mares to the most successful sires. When the mares happen to belong to the same type as the sire (and they are likely to do this if they are both related to ancestors only three or four generations removed) there is a chance of the offspring proving good performers, but when the mares belong to a different type from the sire the probability is that the offspring by reverting will be characterized by stamina rather than by speed.

From what has been said on the principles of breeding, it follows that Warfield's maxim, "Breed the best to the best, avoiding close affinities," might well be extended to "Breed the best to the best, but avoid crossing different strains and different types of the same strain, and, as a rule, avoid close affinities."

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THE ANCESTRY OF DOMESTICATED CATTLE.[1]

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I. SOME PROBABLE ANCESTORS OF DOMESTICATED CATTLE.

INTRODUCTORY.

The origin of our domesticated cattle has been the special object of study of many investigators, but the results of their labors have been written largely in foreign languages and have been published in widely scattered periodicals. In this article an attempt is made briefly to review and correlate the progress made by the many zoologists, paleontologists, anthropologists, and historians who have worked on this difficult problem, as the original publications are inaccessible except to those living in the vicinity of large libraries.

Many details which would be of interest to the zoologist have been omitted because it is presupposed that the majority of the readers of this article will be men interested in cattle breeding, who desire to obtain a general survey of what is known concerning the ancestry of European and American cattle but who are too preoccupied with other duties to read a mass of osteological details that would be both interesting and necessary to the scientist who is making a special study of the evolution of species. For those who care to pursue the subject further, a bibliography of some of the more important contributions to the subject is appended. The reader should also bear in mind that many facts regarding the ancestry of cattle are still unknown. Hence, those who are in haste to have all questions settled once and for all will derive but little cheer from the following pages. Much work remains to be done before final conclusions can be reached, but there may be some who, like the author, wish to know of the progress which has already been made, and for such the present work has been prepared.

By the term "cattle" we usually mean domesticated bovine animals, principally of two species—*Bos taurus*, European cattle, and *Bos indicus*, the humped cattle of India and Africa, commonly called

[1] The two papers comprising this article were delivered, in a somewhat abbreviated form, as lectures at the graduate school of agriculture at Ames, Iowa, in the summer of 1910. The author desires to acknowledge his indebtedness to the writings of Lydekker, Rütimeyer, Werner, Nehring, Wilckens, Keller, and Dürst, in particular, and to many other authors, some of whom are referred to in the text.

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the zebu. The older writers in England used "cattle" or "cattell" as a collective name for all kinds of live animals held as property or reared to serve for food or beasts of burden, and the term sometimes included horses, sheep, swine, and by some writers even bees and poultry. Bovine animals were then designated as "horned cattle," and still more recently as "black cattle" and "neat cattle." "Black cattle" was probably first applied to the black breeds of Scotland and Wales. Later it had a more general application. "Neat cattle" were so designated because they were useful, "neat" being derived from the Anglo-Saxon word "neótan" (to make use of). The word "cattle" is another form of the word "chattel" and "capital," meaning originally goods or property, cattle among many primitive peoples being the most valuable goods, and frequently the measure of value of other kinds of property. The old English equivalent for cattle is "kine" or "kyan," derived from cy, the plural of cu, Anglo-Saxon for cow. The term "ox" is often used for cattle in general, but in a restricted sense it signifies mature castrated male cattle used for draft purposes, though in Continental Europe the term has sometimes been applied to a male not castrated.

HISTORICAL SKETCH OF THE BOVIDÆ.

Domesticated cattle have been derived from wild species of the genus *Bos*, which is one of the largest genera of the family Bovidæ. The members of this family, like all ruminating mammals, possess hoofs with an even number of toes. Among the noticeable features which separate them from other ruminants are the persistent horns with a bony horncore.

The earliest traces of hoofed animals are fragments of bones discovered in New Mexico, which were found embedded in deposits formed in the geological period known as the Eocene. It is difficult to distinguish the forerunners of these herbivorous animals with hoofs from the carnivorous species that had claws. Both walked on the soles of their feet, provided with digits that might answer either for claws or for hoofs. Before the close of the Eocene period typical hoofs had developed in animals living in both North America and Europe. As hoofs developed some of the digits were lost. In later Tertiary formations many changes of the skeleton took place, which led to the inference that small marsh and forest dwelling animals feeding on succulent vegetation had gradually changed into hard-hoofed quadrupeds fitted for life on grassy plains and provided with powerful grinding teeth capable of masticating coarse and dry herbage. A thickening of the brain case, often bearing horns, the disappearance of the incisor and canine teeth from the upper jaw, an increasing height of the molar crowns, and a reduction of digits from five to two, were some of the important skeletal modi-

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fications which may be correlated with the incoming of grasses as a dominant feature of the landscape (Woodward, 1898).

The even-toed Ungulata (Artiodactyla) had their chief development in Europe, and after the Eocene period there was a great variety of forms. The ruminating Artiodactyla became vastly expanded and diversified. They were plastic, adaptable, and eventually migrated to all the continents except Australia, but perhaps did not reach North America until the Miocene period, at which time they were far advanced toward the specialized forms found in the present era. In the Miocene of Europe and southern India remains have been found of deerlike antelopes that were formerly thought to be the lineal descendants of earlier forms of the Tragulidæ. Some paleontologists, however, do not think that the Tragulidæ are in a direct line of bovide ancestry.[1] The Miocene antelopes referred to above, in the opinion of some paleontologists, mark the first appearance of the Bovidæ, which includes sheep, goats, musk oxen, and antelopes, as well as cattle. It is the youngest and most specialized family of hoofed animals, having reached their best development only during the present geological period. Members of the family have been found in all parts of the globe except South America and Australia. In North America it is represented by the bison, musk ox, mountain sheep, mountain goat, and a few allied fossil forms. Remains found in Alaska indicate that some of these species may have migrated from Asia in comparatively recent times. Africa appears to be the center of distribution, although their original home may have been in Asia. The Cervidæ, or deer family, is closely allied to the Bovidæ, but they have solid horns, which branch and are shed annually, while the Bovidæ have persistent, unbranched horns, with a body horn core which is surrounded by a horn sheath that grows continuously from the base. *Antilocapra*, an antelope of western North America, known as the pronghorn, is a connecting link between the two families. Its horns are branched and the horn sheath, but not the horn core, is deciduous. Other characteristics of the family Bovidæ are described by Lydekker as follows:

No members of the family, either living or extinct, possess upper canine teeth, or tusks, which are frequently so strongly developed in the deer tribe (especially when antlers are wanting); and in this respect the hollow-horned are clearly more specialized than the antlered ruminants. Very rarely do they show those tufts and glands on the lower part of the hind legs which form such a characteristic feature in many of the deer.

Further evidence of the specialization or high grade of the family is afforded by the fact that the lower ends of the metacarpal and metatarsal bones, which persist in so many of the deer, have invariably disappeared. Then, again, the lateral toes are very generally represented merely by the lateral hoofs, although in certain cases some small nodules of bone within them represent the skeleton

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[1] For a discussion of this subject see Gregory.

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of these portions of the limbs. Moreover, in some members of the family (although in none of those described here) even the lateral hoofs themselves have disappeared and the main hoofs alone remain.

The geological position of the Bovidæ is shown in figure 8.

THE GENUS BOS AND ITS FIVE SUBGENERA OR GROUPS.

The genus *Bos* is the most specialized division of the family Bovidæ, as is shown by the structure of the teeth and by its late appearance, geologically speaking. Lydekker has enlarged the genus so that it includes the species formerly known under the genera of

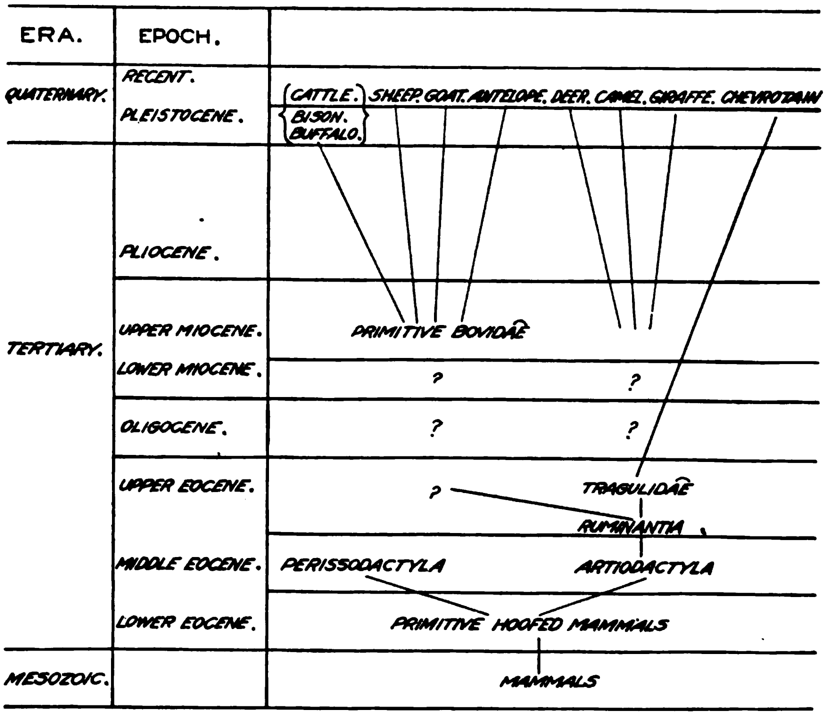

FIG. 8.—Diagram showing geological position of the Bovidæ.

Bos, *Bibos*, *Leptobos*, *Amphibos*, *Bison*, *Bubalus*, *Probubalus*, and *Buffelus*. He makes five subgenera, however, which correspond closely to the genera of the older classification. The five subgenera or groups he designates as (1) Taurine, which includes our common oxen and the humped cattle of Africa and Asia; (2) Bibovine, composed of the gaur, gayal, and banting; (3) Leptobovine (extinct species only); (4) Bisontine, which includes the yak and bisons; and (5) Bubaline, or buffalo group.

The size of the wild species that are members of the genus *Bos* range from that of the anoa, which is only 3 feet 3 inches in height

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at the shoulder, to the banting and the gaur, which measure nearly 6 feet in height. Among domesticated cattle we find that some individuals of the Dexter-Kerry, Brittany, and Permian breeds, as well as cattle at the North Cape, are only a little over 3 feet in height. The domesticated water buffalo is sometimes 6½ feet high, and some specimens of the sacred oxen of Ceylon are said to be only 2 feet 2 inches in height.

TAURINE GROUP—SUBGENUS BOS.

The Taurine group is differentiated from the other groups as follows: Typically, the horns are nearly or quite cylindrical, and are situated far apart on a ridge which forms the extreme vertex of the skull that overhangs the proper occipital surface of the latter; the forehead of the skull is flat, elongated, with a long interval between the bases of the horn cores and the sockets of the eyes, which are not tubular; the nasal bones are relatively elongated; the back alone is nearly straight, except in the zebu; the hair is uniformly short; the legs are typically without sharply defined "white stockings;" the seventh or last cervical vertebra is short; the spines of the dorsal vertebræ are of moderate height and slope regularly away to the lumbar vertebræ, thus producing the comparatively straight line of the back. The upward production of the vertex of the skull, so as completely to shut out the occipital surface in a front view, and the abbreviation of the parietal zone, indicate that the Taurine, Bibovine, and Leptobovine groups are the more specialized of all the oxen, but as regards the vertebræ the Bisontine group is more advanced than the Taurine. (Lydekker, 1898.)

Members of the Taurine group formerly ranged from Europe, Asia, and North Africa, although none are found wild to-day except where they may have escaped from domestication. All domesticated forms without the hump Lydekker reduces to one species, *Bos taurus typicus;* those possessing the hump, to *Bos taurus indicus.* These two types have played the greatest rôle in civilization of any of the Bovidæ and have no near wild representatives now living.

BIBOVINE GROUP—SUBGENUS BIBOS.

All of the Bibovine group are humped forms and are natives of southern India. The forehead is shorter than that of the Taurine group, the width at the base of the horns is less, the tail is relatively shorter, and the legs are wide from hock to hoof. The banting and the gayal have been considered by some zoologists as distinct species, while others regard them only as forms of the gaur, one of the largest and most magnificent members of the family.

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LEPTOBOVINE GROUP—SUBGENUS LEPTOBOS.

This group consists of extinct species only, and the different members will be treated later.

BISONTINE GROUP—SUBGENUS BISON.

The important members of this group are the European bison, the American bison, and the yak. They may at different times have been crossed with *Bos primigenius* and *Bos longifrons*, as the American bison is being used at the present time in the United States with some of the best beef breeds with the expectation of producing a better breed of beef cattle than any now known. The resulting cross is commonly spoken of as a "cattalo."

Bos grunniens, or the yak, ranges over nearly the entire central part of Asia. The domesticated yak, though somewhat smaller in size, is probably derived directly from the wild form. Kohler, however, thinks the domesticated form is a cross between the wild yak bull and a domesticated cow of the Taurine group. Regel (1884) also is of the opinion that there is yak blood in the long-haired cattle of the upper Oxus.

BUBALINE GROUP—SUBGENUS BUBALUS.

The buffalo is a domesticated animal of considerable importance in southeastern Europe and southern and eastern Asia. It is used as a draft animal and for beef production, and in some sections is the principal dairy animal.

The domesticated buffalo was known in Europe previous to Roman times. It was first introduced as a domesticated animal into Italy at the end of the sixth century. Before that time it was common in the region of the Danube and had probably come from Asia. There was, however, a Pleistocene form, *Bos antiquus*, the Algerian buffalo, which roamed from Algeria to South Africa, and it is possible that the different species of domesticated buffaloes have originated from several wild species of this group.

EXTINCT SPECIES IN RELATION TO ANCESTRY OF DOMESTICATED CATTLE.

In considering the extinct species which may possibly be ancestors of domesticated European varieties of cattle one can not at present go back further in geological history than the horizons in the Pliocene epoch.

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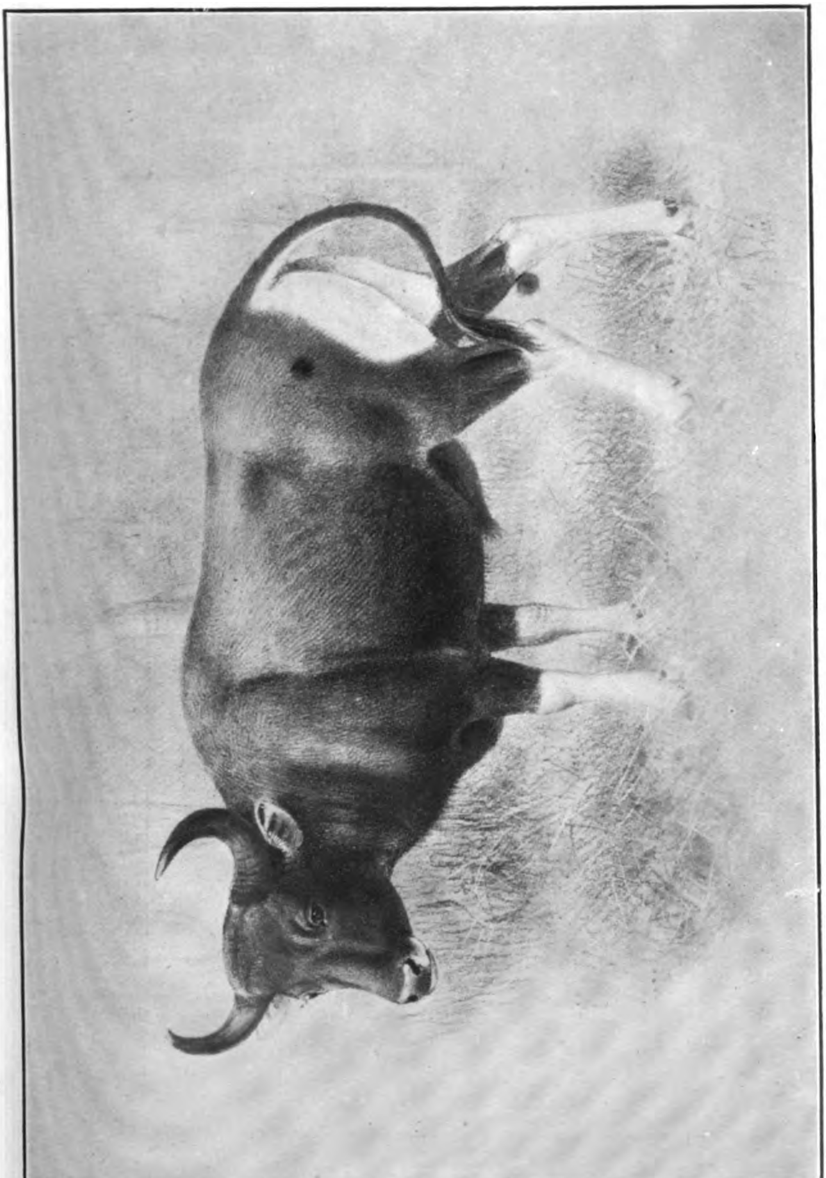

THE BANTING. (FROM LYDEKKER.)

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PLIOCENE EPOCH.

Geological distribution of the principal species of wild oxen.

Geological epoch.	Asia.	Africa.	Europe.	America.
Recent.	*Bos primigenius.* *namadicus.* *indicus* (zebu). *Bibos gaurus* (gaur). *frontalis* (gayal). *sondaicus* (banting). *Peophagus grunniens* (yak). *Bubalus* (many species).	*Bos indicus.* *Bubalus caffre* (5 races).	*Bos primigenius.* *Bison bonasus.* *caucasicus.*	*Bison bison.*
Pleistocene.	*Bos primigenius.* *namadicus.* *Leptobos fraseri.* *Bison priscus.* *Bubalus palæindicus.*	*Bos primigenius.* *mauritanicus.* *Bubalus antiquus.* *Bison priscus.*	*Bos primigenius.* *Bison priscus.* *Bubalus pallasi.*	*Bison latifrons.* *occidentalis.* *antiquus.* *crassicornis.* *alleni.* *ferox.* *bison.*
Pliocene.	*Bos acutifrons.* *planifrons.* *Leptobos falconeri.* *Bison sivalensis.* *Bubalus triquetricornis.* *acuticornis.* *platyceros.*		*Leptobos elatus.* (*etruscus.*)	Bison [?].

The Leptobovine group in Pliocene time is represented by at least two extinct species—*Bos elatus* and *Bos falconeri*. *Bos elatus*, the Etruscan ox (fig. 9), lived in France and Italy in the late Pliocene. The horn cores of the male grew outward, then curved gradually upward, with an inward tendency at the tips. The limb bones indicate a comparatively slightly built animal. The lower molar teeth have a small additional column on the inner side. Depéret considers *Bos elatus* a bison because of its dentition. *Bos etruscus* (Falconer), originally described as a separate species, is, according to Dr. Forsyth-Major, merely the female of *Bos elatus*. *Bos falconeri* is imperfectly known, but is apparently distinguished from *Bos elatus* by the more slender form of the skull of the male and the more upright direction of the horn cores, of which the bases alone are preserved. Remains of this species are found in the fresh-water deposits of the Siwalik Hills of India, laid down in the early Pliocene.

These species are closely allied to the banting (Pl. XIII), as is shown by the curvature of the cylindrical horns, the shape of the nasal bones, and in the shortness of the skull. On the other hand, the horn cores of the bulls are situated far below the vertex of the skull, midway between the occiput and the orbits. The cows are hornless. Probably the banting (*Bos sondaicus*) is their nearest

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modern relative, which Keller says can not be the ancestor of the large European breeds because the occipital parts are too prominent.

Turning to the Taurine group, we find that *Bos acutifrons*, the Siwalik ox (fig. 10), is found in late Pliocene deposits. It was a large animal, with angulated frontals and with enormous horns, measuring about 10 feet from tip to tip. Rütimeyer regarded this and *Bos planifrons* as forms of *Bos primigenius*, while Lydekker considers them as distinct species. *Bos planifrons*, with shorter horns and flattened frontals, may have been the female of *acutifrons*.

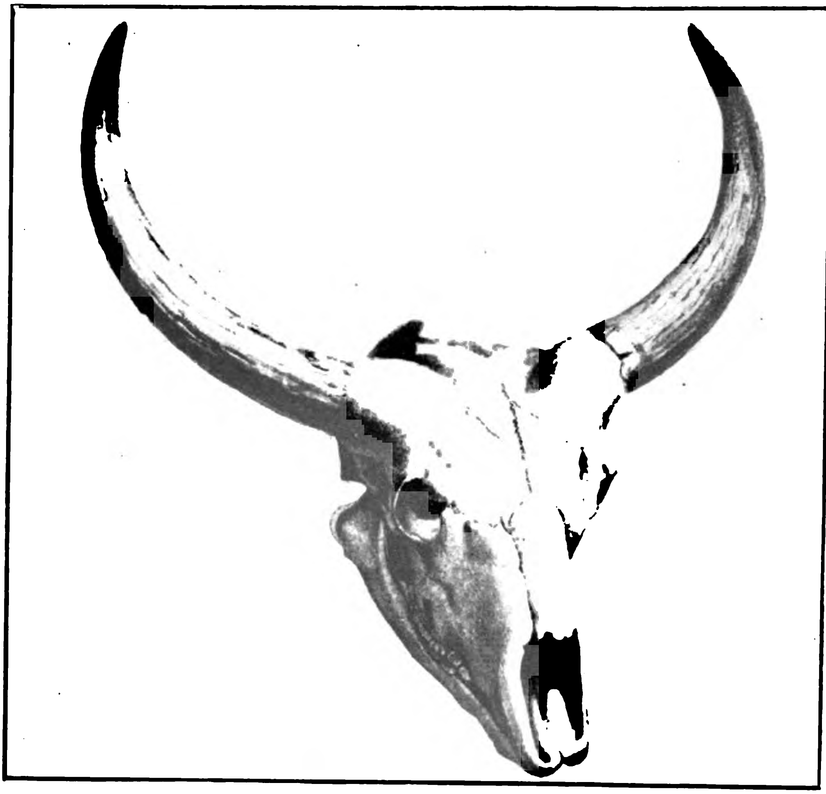

FIG. 9.—Skull of *Bos elatus*. (From Rütimeyer.)

Ewart (1911) has found a modern type of *acutifrons* among the skulls in the Roman fort at Newstead, England.

PLEISTOCENE EPOCH.

In this epoch the species of most interest in the Bubaline group is the Algerian buffalo, previously referred to. (See fig. 10.) A prominent member of the Bisontine group was *Bison priscus*, which roamed over Europe, Asia, and North Africa. This species is probably the ancestor of both the European and American bison. The

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Leptobovine group apparently contained only one species, the last member of the group, *Bos fraseri*, and even this is imperfectly known, as only few fossils have been found in the Narbada Valley, India. It resembles *Bos falconeri* in most respects, but also must be closely allied to the banting, because the horn cores are situated some distance below the vertex of the skull.

In the Pleistocene epoch the Taurine group is represented by *Bos taurus mauritanicus* and *Bos namadicus*. *Bos taurus mauritanicus*, so named by Thomas, is probably identical with *Bos opisthonomus* of Pomel, that lived in Algeria and Tunis until historic times and may be only a variety of the European wild ox, *Bos primigenius*, from which it can be distinguished only by a shorter forehead, larger and

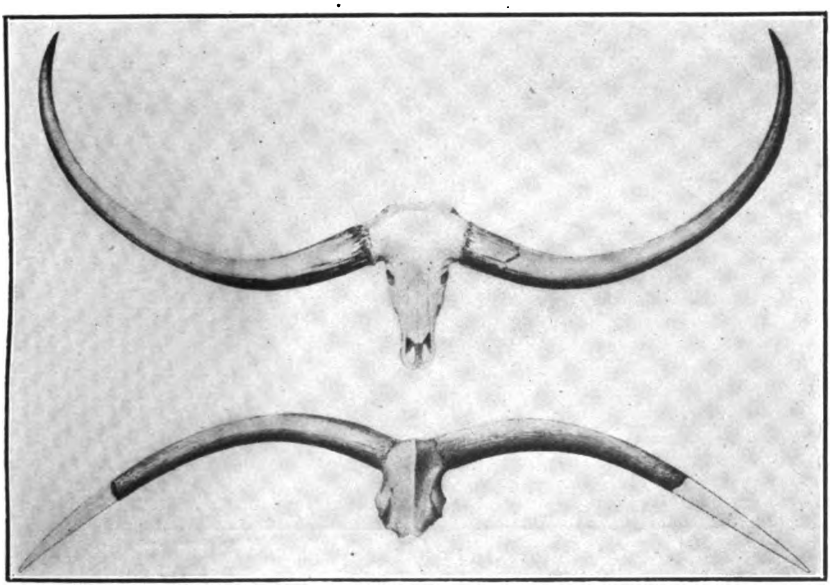

FIG. 10.—Skulls of Algerian buffalo (upper figure) and *Bos acutifrons* (lower figure). (From Lydekker.)

more slender limbs, and with horn cores which curved less forward but more downward. *Bos namadicus*, the Narbada ox (fig. 11), first described by Falconer and later called *paleogarus* by Rütimeyer, is one of the best known species of extinct Indian oxen. It is so closely allied to *Bos primigenius* that it is now considered as the Asiatic and probably older form of *primigenius*. In some specimens the horn cores are somewhat flattened at the base, which shows a close relationship to the Bibovine type. Lydekker suggests that it may have been the ancestor of both the Bibovine and Taurine types, and at the same time a descendant of *Bos acutifrons*. *Bos namadicus* was a contemporary of early man in India during the Old Stone period and has recently been found in the lowest layers of the deposits at

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Anau, Turkestan (Dürst). The cranium of *Bos namadicus* differs from that of *primigenius* in the following points: The short premaxillæ, which do not reach the nasals; the low position of the occipital crest relatively to the horn cores; the arcuated intercornual ridge; the intrusion of the temporal fossæ on to the occiput; the concave plane of the latter, and the regular curve of the occipital crest. In almost all of these points in which the cranium of *Bos namadicus* differs from that of *Bos primigenius* it approaches to the crania of the genus *Bibos*. The peculiar forward curve of the horn cores of this species, as is well shown in the profile view (fig. 11), presents considerable resemblance to the curve of the horn cores of the yak.

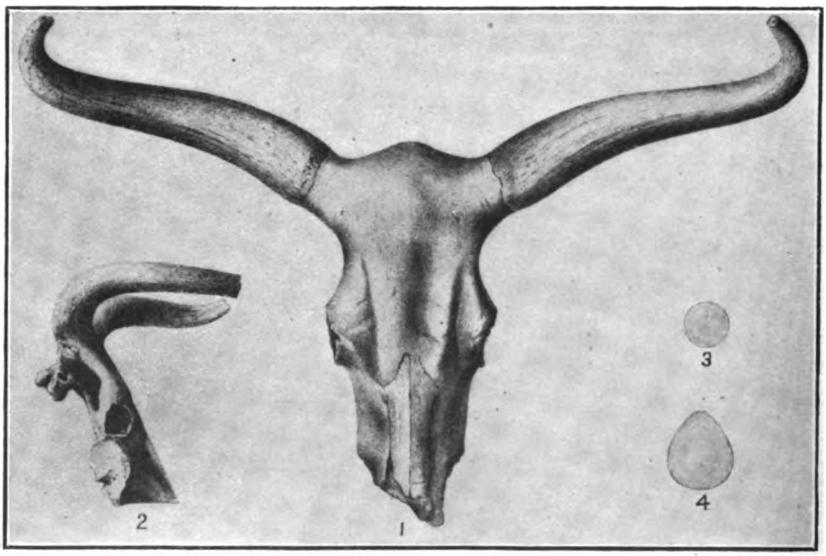

FIG. 11.—Skull of *Bos namadicus*. 1, Frontal aspect; 2, lateral aspect; 3, cross section of horn near tip; 4, cross section of horn near base. (From Lydekker.)

This, however, can not be taken as of any importance in showing kinship between the two animals, as the forms of the crania of the two are so entirely different (Lydekker).

All species of *Bos* which lived in the Pliocene and Pleistocene are now extinct, although the blood of several forms of *Bos primigenius*, *Bos namadicus*, and *Bos priscus* may still flow in the veins of our domesticated cattle. To these species and the representatives of the genus during the Recent or Alluvial periods we must look for the genealogy of our cattle. On the other hand, probably all of the species of the Recent period have played a part in the history of cattle raising.

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RECENT PERIOD.

Bos primigenius.

Bos primigenius (Boj, 1827), a contemporary and probably a variety of *B. namadicus*, was a large and stately animal, being 6 or 7 feet high at the withers. It roamed over western Asia, northern Africa, and the entire continent of Europe during the Pleistocene and Recent periods. Like its near relative the European bison (*Bos bonasus*), it was a forest-loving animal and, judging from old pictures

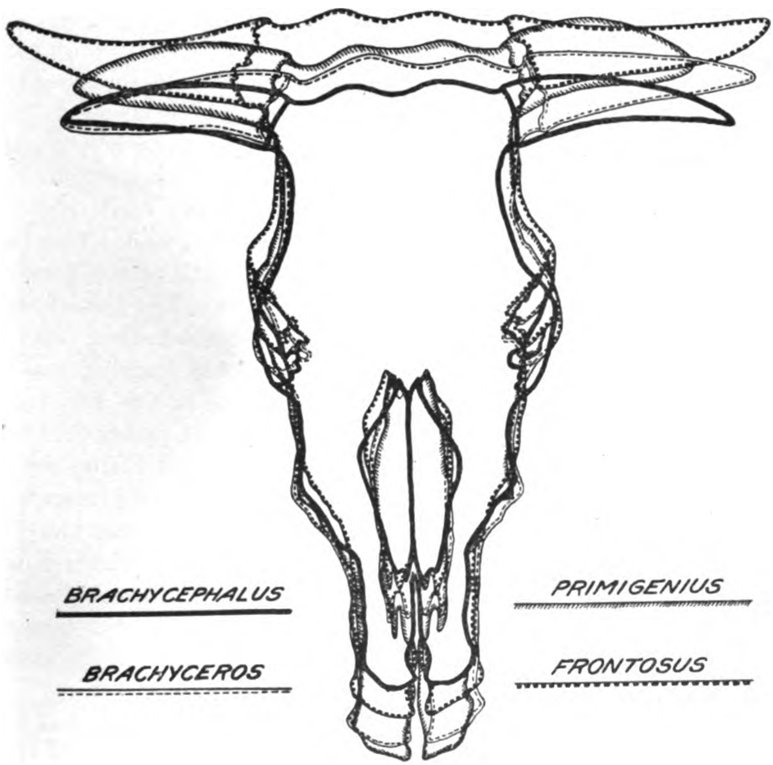

FIG. 12.—Frontal aspect of four types of skulls. (After Wilckens.)

and inscriptions, it had a hairy coat, which varied in color from black or dark brown in summer to gray in winter. A light-colored ring encircled the muzzle, and along the back was a white stripe. Unlike the bison, it had no long hair about the head and neck. To the old Teutons, who used its large horns for drinking vessels, it was known as the aurochs, or ur. But after its extinction the latter name was applied to the bison, which unfortunately has led to much confusion. To the Russians it was known as the tur or thur. Cæsar speaks of it as urus.

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That there were large numbers of them is shown by the numerous fossil remains found throughout a wide region. One of the best skeletons ever found is that of a female apparently from 6 to 8 years of age. The skeleton was dug up in 1887 from the bottom of a peat bog at Guhlen, on the shores of Schweiloch Lake, Brandenburg, Germany, and is now in the zoological collection of the Agricultural High School of Berlin.

This skeleton, as described by Nehring (1888), is very similar to that of the cattle of the lowland and steppe breeds found in Europe to-day, except in such changes as would naturally come about by domestication. The horns of *Bos primigenius*, though slender, were long and strong, forming at first a half circle, then extending outward and a little to the rear. At about the middle they begin to turn to the front and end in a point turned a little upward. The forehead and face were long and narrow, with slightly concave surfaces. The whole cranium was somewhat flattened, the contour lines being comparatively straight. Measurements agree relatively with those of the wild cattle of Chillingham Park, England. The forehead was long, narrow, and quite flat. The length of the forehead was 47 per cent of the length of the entire skull. The size of other skeletons of the ur varies from that of our domesticated cattle to over 6 feet in height at the withers and to 12 feet in length.

The first appearance of *Bos primigenius* was in the Pleistocene period, when Europe had a warmer climate than at present. It was a contemporary of *Bos priscus* (the ancestor of the European and American bisons), *Bos bonasus* (European bison), the mammoth, the Irish elk, and other large animals. *Bos priscus* was more numerous before the appearance of *Bos primigenius*, by which it may have been driven out. The remains of *Bos primigenius* are found in all the earlier pileworks of the Lake Dwellers. It was first domesticated in Neolithic times, and later the wild form was driven out by man.

There is much evidence to show that the wild ur or urus has lived within historic times. It is mentioned by Cæsar, who saw it, or knew of it, as an inhabitant of the Hercynian forest. Seneca speaks of both tame and wild cattle. Tacitus and Pliny say that the horns of these cattle, used as drinking horns, sometimes held as much as 2 urs (12 liters). In the Niebelungen Lied, Siegfried kills a wisent (bison) and four ur. In an old chart, made in 1284, the urus is said to exist between the upper Duna, the Dnieper, and the Carpathians, the same region in which he is thought to have become exterminated in the seventeenth century (Beltz, 1896).

Fraas tells of two Roman statuettes of oxen which were dug from a depth of 9 feet in widening a railway in Swabia, in 1895. One represented a bison, the other an aurochs. So it is presumed that

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both lived in the Black Forest in Roman times; one roamed in the woods of the highlands, the other in the lower meadows.

A painting, presumably made about 1500 and found in 1827 in Augsburg, represents a rough-haired maneless bull, with large head, thick neck, and small dewlap. Its powerful horns turn forward, then outward, and are light colored with black points. The color is sooty black, with a white ring about the mouth. A copy of the picture is in Griffith's "Animal Kingdom," a translation of Cuvier's "Le Regne Animal," Volume IV, and is here reproduced (Pl. XIV, fig. 1). No one knows who painted the picture. Nehring (1896)

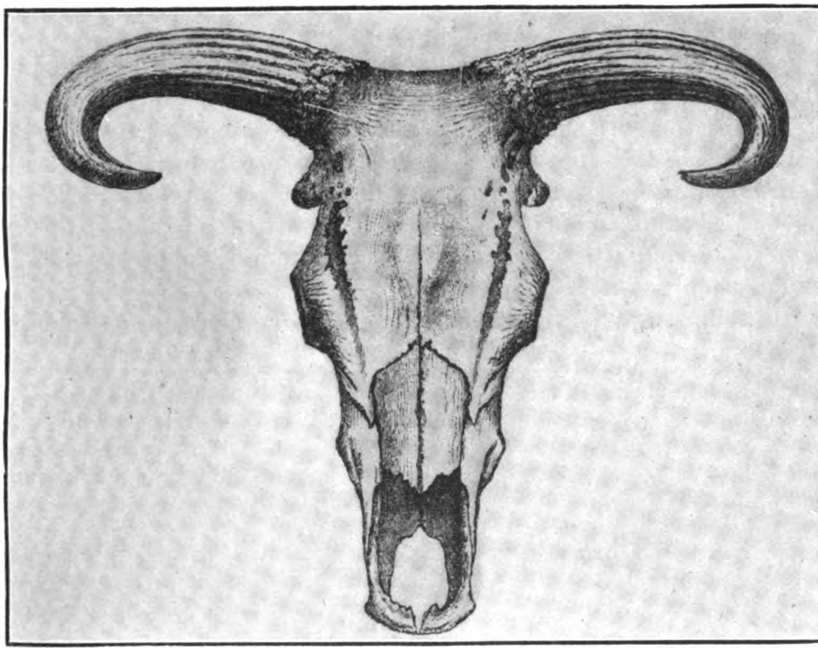

FIG. 13.—Skull of *Bos primigenius*. (From Werner.)

thinks it represents a wild form, while Keller (1897) says it has too fine a nose to be any but a domesticated animal.

In 1889 two golden cups, on which were engraved pictures of cattle, were found in a grave at Vaphio, near Sparta (see Pl. XV). These cups, now in the museum of the Archeological Society at Athens, are evidently the work of a master artist of the Mycenæan period, about 150 B. C. On one is represented a hunting scene with three wild oxen; on the other is a wild ox held by a man, who has fastened a rope about the hind leg of the beast. Two other oxen appear peaceful and domesticated. These figures are supposed to illustrate hunting, capturing, taming, and domesticating. Homer does not mention this wild ox; the Phenician metal worker does not depict him; Egyptians always represent cattle as tamed; so Keller (1897) says

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the artist must have represented European cattle, and as Europe possessed only two, the bison and the ur, this surely is not the bison and so must have been a representation of the ur.

Krause (1898) is of the opinion that the cups were of Babylonian and not Greek workmanship, because the wild steer is represented in a land of date palms. This opinion is refuted by Keller (1898).

A skull, preserved in the castle of Bromberg, Prussia, shows three spear wounds on the forehead. This is surely some evidence that the urus lived so recently in Europe that many European breeds of cattle may be his immediate descendants, although Pallas (1769), Bojanus (1827), and Jarócki (1830) maintained that no one in historical times had seen a living specimen. This is contrary, however, to the opinion of Gesner, Buffon, Cuvier, and many other zoologists who have studied the problem.

Perhaps the best affirmative evidence that both the urus and the European bison lived within historical times is furnished by Baron Herberstain, who lived during the first half of the sixteenth century. According to his own statements he saw both of these animals when he tarried at the court of King Sigismund August of Poland during a journey to Moscow.

The following is a free translation from the German of Nehring (1896):

> Of the wild animals in lands belonging to Lithuania, besides those native to German soil, is one which they call "suber." It is called "bison" in Latin, while Germans call it "aurochs." Closely related to it is another animal, "tur," or Latin "urus." We Germans call it "bisont" incorrectly, for its form is that of a wild ox. Its color is nearly black, with a grayish stripe along the back.
>
> The suber is considerably different from the wild ox; the head is short and the forehead broad. The horns are far apart, but with the points turned toward each other and are effective as a means of defense. Horns have been found so large that 3 large men could sit between them. They are much thicker and shorter than the horns of the urus. The suber is much higher at the withers than at the rump. The hair is coarse and hard, and not so black as that of the urus. Along the throat and neck the hair is much longer than on other parts of the body.

Under one of Herberstain's pictures is the following statement: "I am the urus which the Polonaise call tur, the Germans aurox, and the vulgar bison." Under another, "I am the bison that the Polonaise call suber, the Germans wysent, and the vulgar urochs." It is this Babel of tongues which has helped to obscure the point at issue. Some of the older German naturalists, including Brehm, have called the European wild ox "aurochs" and the bison "urus." French, Italian, Swiss, Belgian, and English naturalists have called the bison "aurochs" and the wild ox "urus."

The first edition of Herberstain's travels was published in 1549 under the title of "Rerum Moscovitcarum Commentarii," and con-

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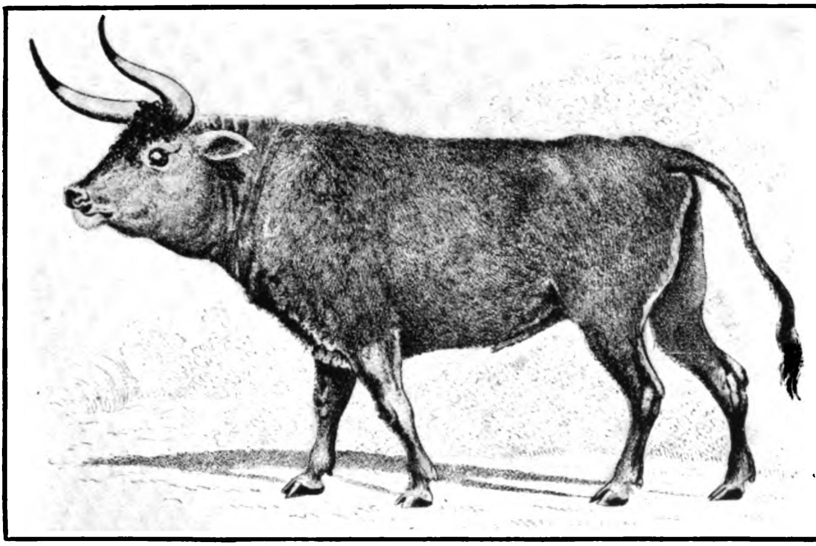

FIG. 1.—THE AUGSBURG PAINTING OF THE URUS.

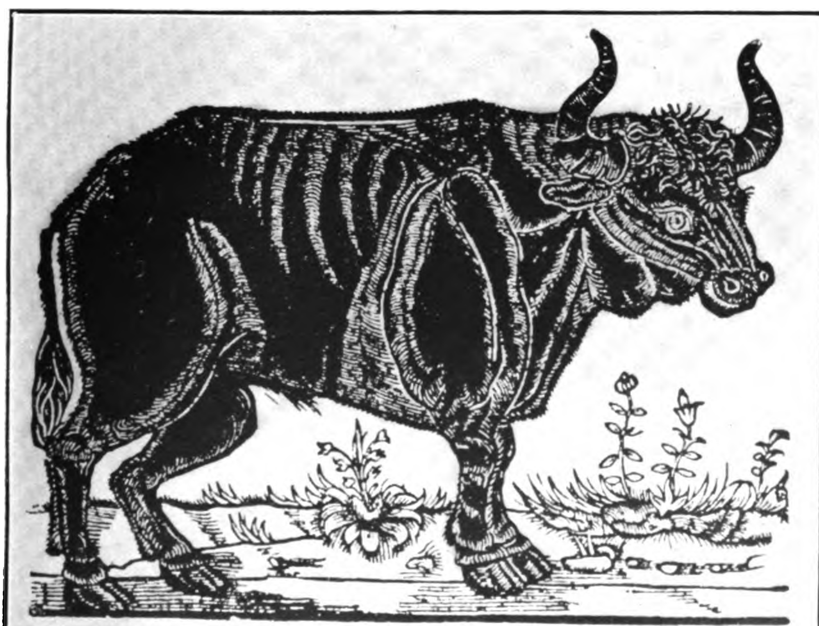

FIG. 2.—HERBERSTAIN'S PICTURE OF THE URUS. (FROM NEHRING.)

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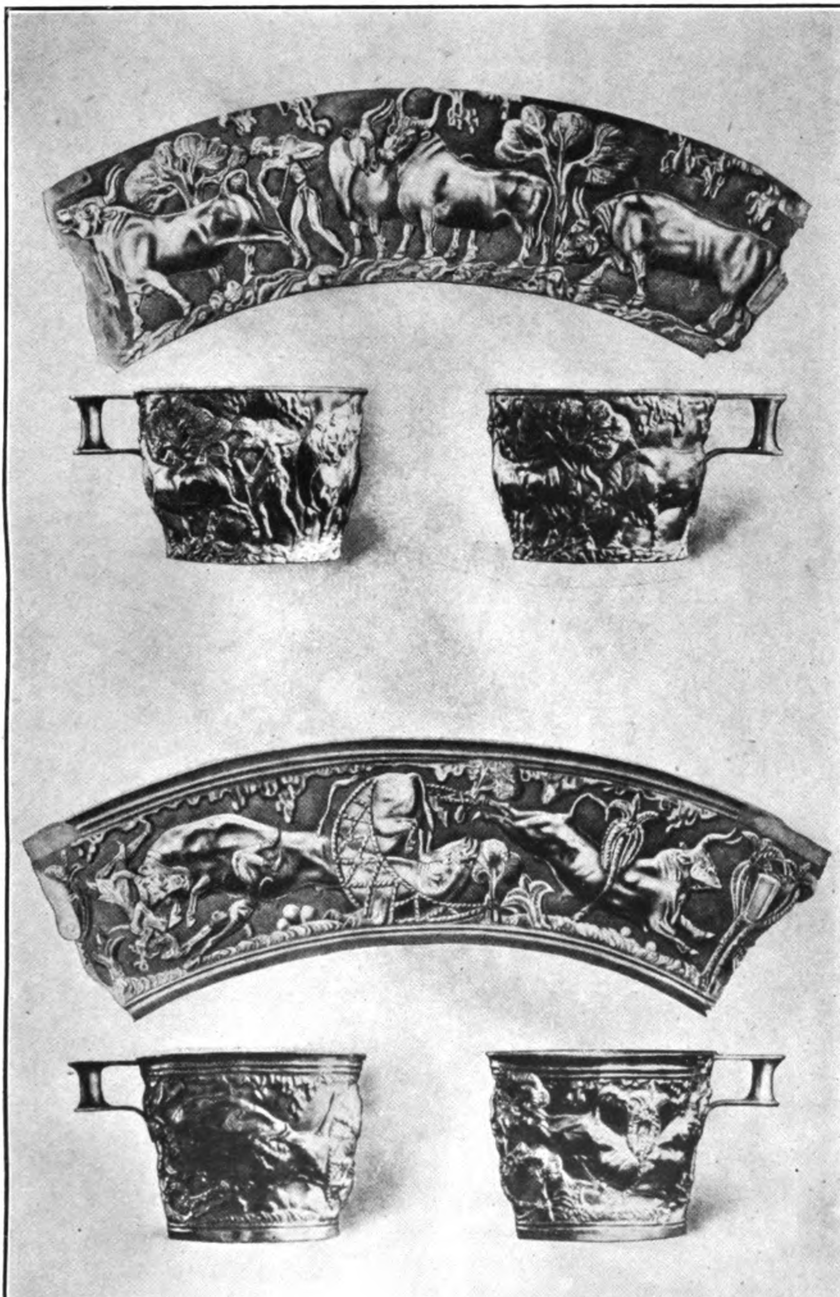

THE VAPHIO CUPS AND THEIR SCROLLS. (FROM RICHARDSON.)

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tains no pictures of either urus or bison. The editions of 1551 and 1556 contain pictures of both. An edition of 1557, published by Johannes Steelsius, says that the forest cattle (*Boves sylvestris*) differ from domestic only in being black with a white stripe along the back. An edition of 1557, by Wolfgang Lazius, contains no picture. In 1563 Heinrich Pantaleon translated the work into German under the title "Moskowiter Wonderbare Historien," in which is a woodcut that Wilckens (1885) says is not a representation of the urus but rather that of a castrated domestic ox. The horns appear to be lyraform, while those of fossil *Bos primigenius* are not. Wilckens also thought that Herberstain had never seen an urus himself and went to Moscow but once. Nehring (1896 and 1897), who has carefully studied the various editions of Herberstain's work, says that Herberstain went several times to Moscow and had many opportunities to see both the urus and the bison. Pantaleon, his translator, says that Herberstain had a great regard for truth.

The edition of 1551 contains the plates of bison and urus for the first time, and it expressly states that the plates were added by the author himself, who lived for 10 years after its publication. The pictures were not in the first edition because Herberstain did not possess them until about 1550. He allowed Gesner to publish them in an appendix to his "Historia Animalium" in 1553.

No one knows who made the picture, but it was probably done by an artist in Poland who had seen a urus. As to the shape of the horns shown in the picture, it may be said that artists were rare in those days, and it is not an easy task for the uninitiated to draw the correct form of horns on paper. Besides, the fossil horn cores would not show whether or not the horns were lyraform.

A poem by Caspar Betius, entitled "De Uro et Bisonte," published in 1558, indicates that Herberstain possessed skins, horns, and hoofs of the urus and the bison in 1552 (Nehring, 1897).

Wrzesniowski (1878) has pretty good evidence that these wild cattle lived in the woods of Jaktorowka until the seventeenth century. The last specimen died in 1627 in the Zoological Garden of Count Samoisky.

Other fossil species of *Bos* closely related to *B. primigenius* are *B. trochoceros*, *B. frontosus*, *B. brachyceros*, *B. longifrons*, *B. brachycephalus*, and *B. typicus*. In fact they are so nearly related that some and perhaps all of them may be considered as varieties of *B. primigenius*.

Bos trochoceros.

Bos trochoceros received its name from Rütimeyer, who found many skulls of females in the pile-works of the Neolithic and Bronze ages. Because most of the specimens appear to be females we may consider that *trochoceros* is a form of *primigenius* domesticated in

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prehistoric times. The differences between *primigenius* and *trochoceros* are essentially the same as those which appear at the present time between the wild cattle of Chillingham Park and those of Lyme Park in England. In the latter case the change is regressive rather than progressive, as these cattle are presumably reverting to a wild condition from that of semidomestication.

Bos frontosus.

Bos frontosus Nilsson is a fossil species found in Sweden. (See fig. 14.) The contour of the skull is irregular, the forehead is broad, and

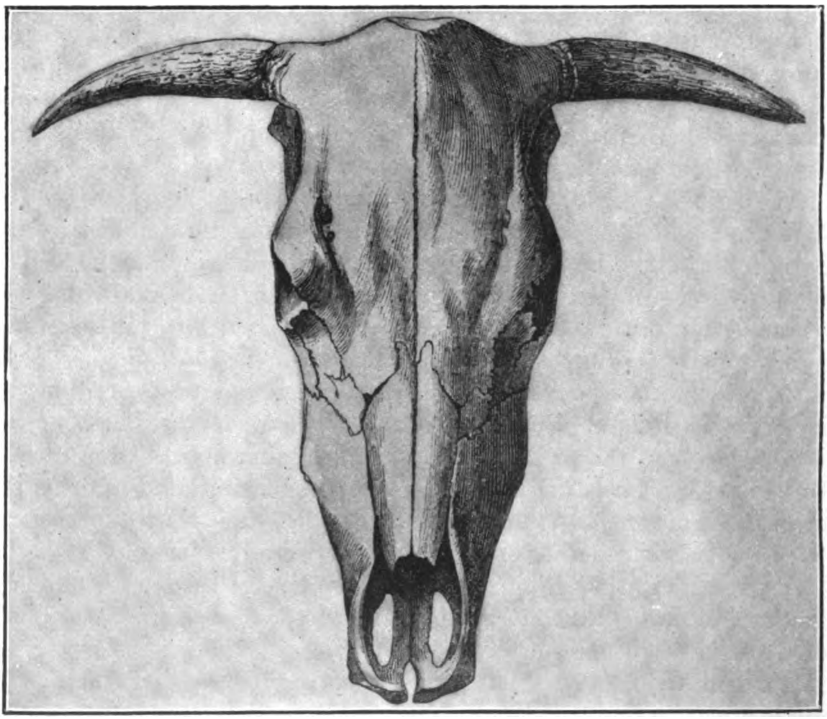

FIG. 14.—Skull of *Bos frontosus*. (From Rütimeyer.)

the horns are situated on a short pedestal. The head is large in comparison with the rest of the body. Nilsson thought it a distinct species having its original home in Germany, and the parent of the mountain cattle of Norway. Rütimeyer (1867) says the Scandinavian remains are those of domesticated cattle. The broadening of the skull is similar to that of the Naita cattle (Darwin) of South America, the Yorkshire swine, and the bulldog. H. von Nathusius says these changes are due to a reduction of muscular activity which accompanies a change in the method of obtaining food. Rütimeyer says this does not explain the shortening and widening of the nasal bones. These changes, however, may be accounted for by the laws

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of correlation. The differences between a skull of *frontosus* and one of *primigenius* are similar to those between a calf's skull at birth and the skull of the same animal at maturity. Why, then, may not the change to the *frontosus* type have been brought about by an earlier maturity which would naturally follow under the care of man?

Frantzius (1878) thought that *frontosus* originated in Africa, while Arenander says it was a sport from *longifrons* and is the ancestor of *primigenius*. It is more likely that *frontosus* is the product of culture during the polished-stone period, with *primigenius* as the ancestor and not the descendant. Rütimeyer, Studer, David, and others maintain that the bones found in the Stone age at Moosedorf and the Bronze age at Concise, Chevroux, and La Tene are those of *frontosus*, while Keller (1902) and others deny that *frontosus* lived in Switzerland in prehistoric times.

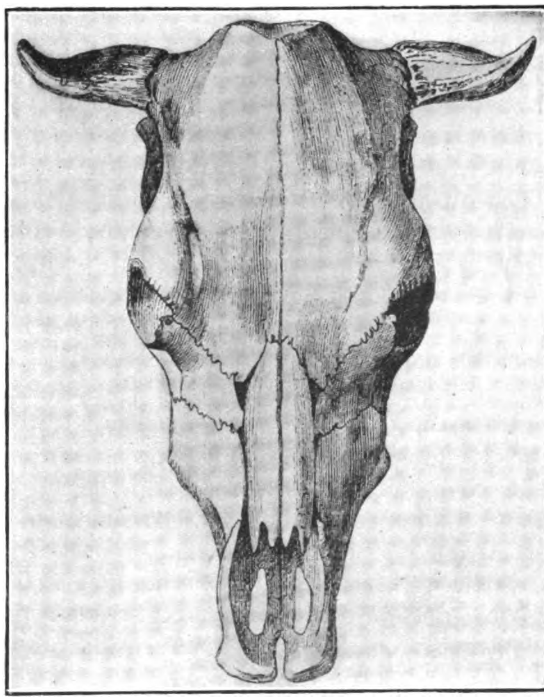

FIG. 15.—Skull of *Bos longifrons*. (From Rütimeyer.)

The Simmenthal and other spotted breeds (Fleckvieh) now in Switzerland and southern Germany are of the *frontosus* type, but Werner says these breeds were carried there by the Burgundians who settled in west Switzerland about 443 A. D., and who brought cattle from their original home in south Sweden. Krämer (1899) is of the same opinion, because neither *trochoceros* nor *frontosus* were in Vindonnissa nor Aquæ Sextiæ during Celtic or Roman times. Although we find a variety of opinions as to the origin of *frontosus*, the reasoning of Rütimeyer, that it was a domesticated form of *primigenius*, seems the most probable.

Bos longifrons.

Bos longifrons, incorrectly called *brachyceros* by some German zoologists, is another species or subspecies closely related to *primigenius*. (See fig. 15.) *Bos longifrons* is the Celtic Shorthorn found

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in England and described by Owen. It is probably identical with the species known as the marsh cow, whose remains have been found in the Swiss lake dwellings, and described by Rütimeyer as *Bos brachyceros*. This latter name must be abandoned; Gray in 1837 had also applied it to a species of west African buffalo. Compared with *primigenius*, *longifrons* is much smaller and has a shorter face but a longer and broader forehead. The horns are shorter, and there is a ridge in the center of the poll. It is found with early remains of man's culture in the marshes of Mecklenburg and Harz, in the lake dwellings of the Stone period at Moosedorf, Wangen, Biel, and Wauwyl. It has also been dug from trenches near Bologna, Italy, and was the most important domesticated animal of the Stone age from the North Sea to Italy. But nowhere has it been found wild with certainty. It is represented to-day by breeds in the Alps, in northern Africa, and in Great Britain.

Owen believed *Bos longifrons* to have existed in Pleistocene times, but recent discoveries point to a later origin (Dawkins, 1866). It lived in England during the Roman occupation and is the ancestor of the Welsh and Highland breeds, as the Celts retreated to the mountains with their cattle on the Saxon invasion. In France it is found in the Mousterian period (Mortillet), and was the only bovine species about Lyons during the Gallo-Roman epoch (Cornevin, 1885).

As to the origin of *Bos longifrons*, Rütimeyer, Wilckens, Keller, and Hughes believe it to be a species distinct from *primigenius*. The earliest traces in Europe and the most typical forms of *longifrons* are found on the northern shores of the Mediterranean Sea, the Alpine region, and the Atlantic coast of western Europe. Breeds of cattle in Africa and Switzerland, as well as the zebu of Asia and Africa, possess strong characteristics of this species. Hence it is argued that *longifrons* must have come originally from some Asiatic species, probably *Bos sondaicus*.

Dawkins, Nehring, Werner, and others deny any other than a European origin of *longifrons*. They say that the form of *primigenius* was very variable and that a changing environment and the dwarfing by domestication resulted in the form now known as *longifrons*. Dawkins (1866) says:

> A walk into a cattle market will convince the most skeptical of observers that the common ox presents also every variation possible in the shape and direction of the horns. In fine, a very careful comparison of the skulls of *B. urus* in Britain with those of various varieties of *B. taurus*, or the common ox, compels me to believe that there is no difference of specific value between them, those points of difference noticed by Profs. Rütimeyer and Nilsson proving to be peculiar to the individual and not to the species, and therefore useless for classificatory purposes.

Urus could be distinguished from any contemporary taurus by his size, and from the smaller bison by the double curvature of his horns,

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etc. Nehring (1896, p. 923) cites proof of dwarfing in case of the yak and the banting when kept in the zoological garden. The effect of an unfavorable environment is shown by the condition of the Permian cattle at the present time.

When cattle of two different breeds are placed in a similar environment, similar changes take place, but nevertheless there is always some distinction left. The conformations are never quite alike. The Jerseys, Norman, Angler, and East Friesian cattle live in a similar environment, yet they are different; it may be because they are of different origin. The Jersey cow has good care and abundance of nourishing food, yet she remains small.

Food, domestication, and a change of climate effect great changes, however, and Nehring can see no greater changes between *primigenius* and *longifrons* than between the wild and the domesticated yak. The dwarfing of cattle from a lack of suitable food is well illustrated in northern Russia (Middendorf) and in the Shetland Islands. When Brown Swiss cattle are taken to the steppes of Hungary their horns grow larger, like those of the natives of that region. In the dry year of 1893 young Oldenburg bulls imported to Saxony grew horns similar to those of dry climates and poor food. Pusch mentioned a case which came under his observation the same year. A bull weighed 500 pounds, and showed no signs of growing larger. He came from a cow imported from Pomerania and was of medium size, with some Shorthorn blood. An analysis of the hay showed 0.27 per cent of phosphorus and 0.86 per cent of lime, when normally there should have been 0.43 per cent of phosphorus and 0.95 per cent of lime.

Nehring also calls attention to the fact that the first animals to be domesticated would be young. This in itself would tend to bring about greater changes than if mature animals only were tamed and provided with food. Even if *primigenius* was a large and unruly creature the young might be as easily tamed as if the mature animal was smaller. It is not size, but the disposition to accept the life offered to it, that determines whether or not an animal is capable of being tamed. Yet Nehring (1888) admits that relatives of *primigenius* may have been independently domesticated in Asia and Africa, although he does not go so far as Rütimeyer in thinking *longifrons* one of these independent species, for the following reasons:

(*a*) Color: *Longifrons* is solid in color, black-brown to gray, with a light back stripe, and *primigenius* was solid black with a light back stripe much like the Brown Swiss cattle.

(*b*) Size: *Longifrons* is smaller, but it is because of unfavorable environment, as a raw climate, poor food, in-and-in breeding, and neglect. Dwarfs and small forms of domestic cattle do arise in this way.

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(*c*) Horns and poll ridge: There is a correlation between the two. If the horns are large the poll ridge or crest is flat or even hollow. When the horns are small, the crest is more or less elevated. This is true of the zebu and the yak as well as of cattle. Shorthorned breeds have a crest of medium size when contrasted with longhorned and polled breeds. The size of the horns depends upon food, care, and many other factors.

(*d*) Skull: A hollow forehead between the eyes and a shortened nose on *longifrons* agrees with modifications which may be brought about by environmental changes. This is illustrated in the Franqueiros and Niata cattle of South America.

Wilckens (1880) says that the lake dwellers would not have tamed *primigenius* when they already possessed the marsh cow; furthermore, that *primigenius* could not have been changed into so small an animal as the marsh cow. The marsh cow, not being found wild, must have been brought there after domestication in Asia. The only alternative is to derive the marsh cow from *Bibos*. The zebu is the nearest to *Bibos* of any of the taurus group and is not found wild except when it has escaped from domestication.

Wilckens divides cattle into dolicocephalic and brachycephalic, and thinks that the long-headed European cattle which form the greater number came from Africa, but as they are not wild there, had wandered thereto from Asia. The short-headed cattle are natives of Europe and descendants of *Bos etruscus*, which, according to Rütimeyer, is the common ancestor of Bibovina.

The recent studies of Ewart (1911) indicate that *longifrons* is more intimately related to the zebu than the wild urus.

In the first edition of "Rinderzucht," published in 1890, Werner (p. 32) says that blood from the Bibovine group can affect only a few breeds in southeastern Europe, a statement which he has omitted from an edition published in 1902.

Adametz (1898) was formerly of the opinion that *Bos longifrons* had its origin outside of Europe, until he saw the fragment of a skull in the museum at Krakow, which, he thinks, throws some light on the subject. The bone in question was found in West Galicia, at a depth of 12 feet, in diluvial strata, as was *primigenius*. It evidently belonged to a mature individual of the female sex, and, according to the rules of Rütimeyer (1862), was of wild stock. Adametz thinks it more like modern European *longifrons* races than *primigenius*. An important point is that the relative distance from the base of one horn to the other is larger in modern *longifrons* races, also in the ancient marsh cow and in his specimen, than in *primigenius*. Adametz concludes that here he has a variety of *primigenius* which probably arose as a spontaneous variation before domestica-

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tion and is the ancestor of the marsh cow of northern and eastern Europe and of the Polish breeds of to-day, while *Bos longifrons* of the Swiss lake dwellers came from another variation of *primigenius*. He thus finds a European ancestor for one variety of marsh cow and designates it *Bos brachyceros europæus*. Future discoveries may prove Adametz to be right in his conjectures, but the finding of a fragment of one skull is not sufficient evidence to settle beyond all reasonable doubt the question at issue.

Bos taurus primigenius *variety* minor.

Wollemann (1891) found a skull of a domesticated *Bos*, which was about the size of *longifrons*, but in form resembled *primigenius*, and so gave it the name as given above. There have also been many fragments of bone found in company with the marsh cow among the remains of the lake dwellers which Studer thinks should be placed under *primigenius*.

Bos taurus brachycephalus *Wilckens*.

From a study of Alpine breeds in East Tyrol, Wilckens finds a variety of domesticated cattle of which the Duxerthaler breed is a pure type. This type also occurs in the Canton of Wallis. The head is short, the forehead broader than long, and the horn is on a short pedestal. Afterwards he found parts of skeletons in the pile-works of the Laiback moors, which date back to the Old Stone period. To this type he has given the name of *brachycephalus*, or short-headed race.

The bones are quite different from those of the ur, and, furthermore, the remains of ur seldom occur at Laiback. The remains of bison and of these short-headed cattle occur frequently together. The skulls of bison resemble somewhat these short-headed cattle, and the skulls of calves of the modern short-headed breeds bear a still closer resemblance. This is in accord with the view that the individual recapitulates the history of the race, and that ancestral traits may often be seen in the embryo even when absent in the adult. Bison were very abundant in early times in that region, as shown by the numerous remains as well as by the geographical names, such as "Wiesenthal," "Wiesendorf," and "Piesendorf," which are derived from the word "Wisent" (German for "bison"). Therefore, Wilckens thinks that the short-headed cattle of the Alps are of European origin and were brought there by the Celts and crossed with bison, giving rise to this variety, *Bos brachycephalus*.

For these extreme views Wilckens has been attacked from all sides. Rütimeyer thought that *brachycephalus* was not a distinct type of equal value with *primigenius* and *longifrons*, and that the short-

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headedness is only the beginning of the pug form already mentioned under *frontosus*. Wilckens admits this influence of culture, but it so happens that many breeds of this type occur in regions where there has been less improvement in breeding than where other types are found.

Keller (1902) and Krämer (1899) say that *brachycephalus* appears first in Italy and is a product of culture from other forms. From Italy it was carried to Switzerland during the Roman occupation. Kaltenegger shows the affinities of the Wallisian breeds to those of the Iberian peninsula and to the old Egyptian representations, and suggests that the origin of the Alpine short-headed cattle is from one of these sources.

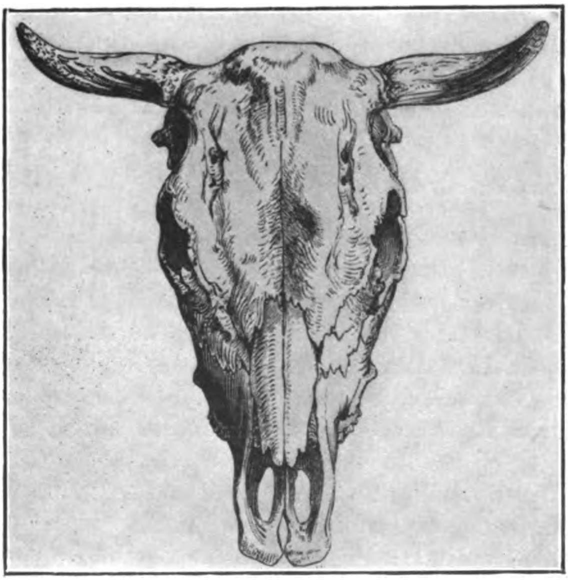

FIG. 16.—Skull of *Bos brachycephalus*. (From Wilckens.)

The measurements of Werner indicate a close relationship between the Iberian and the humped cattle of Africa. The Alpine short heads differ from the humped cattle only in the relative height at the withers and length of horn. Both this excessive length of horn and height at the withers are easily bred off when crossed with other cattle. *Bos primigenius* has been found fossil in Algeria, and it is a reasonable supposition that the humped cattle were crossed with *primigenius* and that the progeny passed over to Spain and thence to Switzerland.

If, however, the fossils found by Wilckens are as old as he believed and are not fragments of *frontosus* (Rütimeyer, 1878) his idea of a distinct short-headed race of ancient lineage is not so easily disposed of. In the meantime we may patiently wait for future discoveries to fill in the vacancy between the paleolithic and modern short-headed kine.

BOS ÆGYPTIACUS AND BOS MACROCEROS.

The first of these names has been proposed by Lydekker to designate the ancient Egyptian cattle as typified by Lortet in the archives of the Lyons museum for 1903, and is a synonym of *Bos africanus*

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of Fitzinger and Brehm, the question being left open whether these cattle should be regarded as a distinct species or merely as a local race of the domesticated *primigenius*. A modern representative of this type is the ankoli, the longhorned humpless breed of Uganda. Their enormous horns are slender, smooth, upright, and are placed at a much greater distance above the eyes than is the case of the Galla cattle which are a type of humped cattle. *Bos macroceros* is the term proposed by Dürst to designate the type represented by longhorned cattle of Egypt.

Bos indicus.

Bos indicus, or the zebu, includes the humped cattle of Asia and Africa. Col. Yule (1875) says the term zebu is a fantastic name which Buffon heard in a wandering menagerie. The name is not known in India and has probably been derived from the Polish zubr or suber. Perhaps the most notable characteristic of this species is the hump at the withers, although the large drooping ears, the shape of the skull and horns, the white shanks and the grunting cry readily distinguish it from other species. Its habits, such as seldom seeking the shade, and never standing knee-deep in water, are also characteristic, though varying as those of any species must with so wide a geographical distribution. Some races have two humps; the ribs may be 13 or 14 in number, and the horns vary greatly in size and curvature.

No wild form has yet been found, although some instances are known where they have become semiwild and were able to maintain themselves even in a region infested with tigers. Crosses with other breeds of cattle indicate a highly bred animal which has varied much from its original form as it came under the dominion of man, which took place previous to 2000 B. C., if we may judge by carvings and inscriptions in Egyptian monuments that date back as far as the twelfth dynasty.

Hahn is inclined to think that African and Indian zebus had a different origin. No fossil remains have been found in central and southern Africa, so Adametz (1894) says they are of Asiatic origin, with the banting as their ancestor.

It is quite possible that zebu blood has also entered into the longifrons type previously discussed.

Bos triceros.

This is a three-horned humped ox found in Senegal and described by Huet (1891). The third horn is on the nose, like that of a rhinoceros. In all probability this variety is a sport from the zebu.

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BOS CHINENSIS.

Swinhoe (1870) describes the small yellow cow of south China as combining the character of *taurus* and *indicus*. Blyth says it is a cross between the two.

POLLED CATTLE.

Calves without horns occasionally appear as spontaneous variations in nearly all districts where cattle are kept. The cause of this variation has not yet been satisfactorily explained. Herodotus (500 B. C.) speaks of the hornless condition of Scythian cattle, in what is now European Russia, as due to extreme cold which dwarfs the growth of horn. Warm, dry climates favor the growth of horns and hoofs. As previously noted, Brown Swiss cattle taken to the steppes of Hungary take on more and more the form of the horns of Hungarian cattle even without crossing (Wilckens, 1876). But if cold is unfavorable to the growth of horn, how can we account for the horns of the musk ox (*Ovibos*), a near relative and an inhabitant of an extremely cold region? In proportion to its size the musk ox has larger horns than most forms of *Bos taurus.*

Whether the polled condition is the result of progression or regression has given rise to much discussion. Dürst says the hornless cattle are the result of domestication. An intermediate stage is the "flaphorn" or movable horn. They are represented in Egyptian works of art. Aristotle knew of cattle with movable horns. Keller has seen them in many places in Africa within recent years.

Flap-horned cattle and sometimes hornless cattle have rough protuberances where the horns otherwise would be, and occasionally small horns may develop as the animal grows older. After many generations these bunches or scurrs disappear. So far experiment has not shown that the hornless condition can be hastened by dehorning. Dürst calls attention to the long horns on the old Egyption representations of the crooked-nosed goat. The modern representatives of this type are either polled or shorthorned. In the time of the Pharaohs, sheep were always horned. All of these instances he cites as a result of domestication.

Arenander (1898) thinks the first cattle were without horns. A study of the geographical distribution of polled cattle in Europe shows them to be more numerous in northern latitudes, which can not be explained by artificial selection by man, for it is unlikely that among people of so many different tendencies the northern people should have always chosen the polled breeds in preference to the horned and the southern people the reverse. We find also among many of the northern people who have polled breeds, that the art of breeding is but little developed. As we go toward the north the proportion of cattle with white hair increases, which evidently is

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the result of natural selection as in the case of wild animals in a region of snow and ice. Polled cattle are also found in the lake dwellings and hence have been among the early forms domesticated. Again, polled cattle are notoriously prepotent in transmitting this characteristic when crossed with horned cattle. In the struggle for existence polled individuals would be less likely to survive than those with horns, but under domestication would be protected. Thus, Arenander supposes that horned individuals occurred by spontaneous variation and were preserved by natural selection and that polled individuals which occur are reversions.

Arenander (1898) is criticized by Keller (1899), who says that the remains of hornless cattle found in the lake dwellings are in the later ones, while according to Arenander it should be the reverse.

Hehn and Middendorf (1888) think the polled breeds of the north came about because the Scythians wandered farther and farther to the north and took their polled cattle with them. This is stoutly denied by Werner (1902) who thinks the migration of people as well as of cattle was to the south instead of toward the north.

In the Upper Eocene and Lower Miocene the generalized form of deer and antelopes was polled and their associates were tuskless swine and rhinoceroses (Auld, 1887). In the Upper Miocene the antlers of deer were small. Darwin quotes a graduated series of antelopes from the polled condition. The pronghorn as we have seen is an intermediate between the deciduous solid-horned and the non-deciduous hollow-horned forms (Gadow). Hence it may be that the horned condition was not reached until the primitive form of deer, antelope, and cattle had differentiated into forms closely conforming to the present types. That the cows of the oldest member of the cattle kind, *Bos elatus*, were without horns lends support to this view. According to Forsyth-Major, the hornless skulls from the Tertiary deposits of the Val d'Arno in Italy are females of the subgenus *Leptobos* (*Bos elatus* Pomel). Until earlier representatives of the genus are found we must consider the oldest European forms of cattle as having polled females, an indication that in still older species both sexes were without horns.

Ewart (1909), after reviewing the various theories of the occasional appearance of hornless cattle, expresses the view that domestication and the unfavorable conditions which are thought to have reduced *Bos taurus* in size may also have led to the hornless condition. Recent explorations in Turkestan and records from Babylonia lend support to this view, i. e., that the appearance of the polled character is a reversion to the ancestral hornless type.

In a recent paper (Scientific Proceedings, Royal Dublin Society, vol. 12, No. 15, June, 1909), Prof. James Wilson, of the Royal College of Science, Dublin, attempts to show that the hornless breeds of

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Great Britain had a common origin, which can be traced back to Scandinavia. This is contrary to the prevailing view that the British hornless breeds have originated independently.

ORIGIN OF THE MODERN BREEDS OF CATTLE.

Regarding the origin of *Bos taurus domesticus* (typicus) and the modern European breeds of cattle it may be asked, Did our modern breeds come from more than one species? If from more than one, can the various breeds be classified according to their ancestry? What was the original home of the wild ancestor or ancestors? Attempts to answer these questions have been made in various ways, and though we are still in doubt and are likely to remain so for some time, we shall review the opinions of those who have endeavored to feel their way through this mist of bewildering evidence.

At one time Cuvier thought our domesticated breeds came from Asia, but later discoveries led him to change his opinion and ascribe to them a European origin, with *Bos primigenius* as the ancestor. Rütimeyer thought that they were all derived from the European *primigenius* except those of longifrons type, whose ancestor must have been of African origin. Darwin derived them from several species, as he conceived *longifrons* and *frontosus* to be species distinct from *primigenius*. Hahn (1896) says they are descended from *primigenius*, with the possibility of some bison blood, as the geographical distribution of the two species is about the same.

Notwithstanding all the evidence which has been produced since Cuvier's time, Middendorf, Nehring, and Werner still hold to his view that the European *primigenius* was the sole ancestor, because *primigenius* remains have been found chiefly in Europe, and Europe, in their opinion, is the home of the domesticated *Bos taurus*.

Frantzius (1878), Pagenstecker (1878), and Keller follow Rütimeyer in thinking Africa the home of at least some of the ancestors of European cattle, while Hartmann is of just the opposite opinion when he looks to the marsh cow for the ancestry of the cattle in the Barbary states. In this he is probably wrong, for they show too close a relationship to the rest of the cattle of Africa.

Keller (1897, 1899) has made a special study of African cattle, and believes in a diphyletic origin of European breeds, the lowland breeds coming from *primigenius* and the *longifrons* breeds from the African zebu. Unlike *primigenius* no fossil remains of wild *longifrons* have been found, hence we should study the migrations of man to seek its original home.

In the plains of Algeria, Tunis, and Morocco the cattle are small, of the short-headed type, resembling zebus in structure and habits, with the exception of the hump. This is known to zootechnicians as the Algerian race. In the more fruitful valleys some of the cattle

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are larger and possibly have been crossed with European blood. In Nubia the cattle are similar to the Algerian race. Carvings on monuments show that cattle of ancient Egypt likewise were of the same stock. The problem of breeds is complicated in Africa because buffaloes and cattle of other sections have replaced those so frequently lost in epizootics.

The cattle of Abyssinia, known as the "galla," or "sanga," have humps and large horns, but vary much as they have a very wide distribution. The Wahumi or Watussi cattle have horns measuring sometimes 118 centimeters in length and with a capacity of 11 liters (Adametz, 1894). They are also modern representatives of the old Egyptian longhorn of the monuments. Later modifications have given the Bechuana, Transvaal, and Madagascar races. Thus in Africa from south to north there is a constant approach to *longifrons.* The northern branch is shorthorned and humpless, but of ancient lineage, and according to Keller came from Asia in prehistoric times. Its progenitor was a domesticated banting, and collateral relatives are the little marsh cow of the lake dwellers and the Brown Swiss cattle of modern times. Adametz (1898) says an African origin of *Bos longifrons* is impossible. The branches of the Aryan race which have moved the least from this primitive dwelling place (lake dwellings)—the Lithuanians, North Slavs, and Albanians—have cattle to-day which are like those of the lake dwellers. It is probable that these people have the oldest domesticated animals of European origin. The skulls of the marsh cow and those of cattle of some breeds in the Balkan peninsula to-day can hardly be distinguished from one another.

Dürst, from a study of figures and inscriptions on stones, concludes that *Bos longifrons* of the lake dwellers came from Asia in very early times and was domesticated long before Babylonian culture, also that Egyptian breeds came from Asia in prehistoric times. These ancient cattle by their known variability through thousands of years of breeding had three modifications: *Bos macroceros*, which includes the longhorned breeds of Africa, Spain, Portugal, and Brazil; *Bos brachyceros* (*longifrons*), which includes all other horned breeds of Europe; and *Bos akeratos*, the polled breeds, which he thinks may have come from *macroceros* and *brachyceros.*

Kaltenegger (1894), concerning the variations found in the Tyrol, says that the white race, which predominates in the region of Dr. Toldt's brachycephalus division of the people who migrated there, are identical with the white cattle of Italy, southeastern Europe, and western Asia, while the black cattle of the Tyrol are related to the cattle of southwestern Europe and northern Africa. Hence the white cattle of the Tyrol are of Asiatic origin and the black cattle of the same region came originally from Africa.

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Summing up the most important of these heterogenous opinions, we find that Cuvier, Werner, Middendorf, and Nehring believe in a monophyletic origin of European cattle, that *Bos primigenius* was the only ancestor and its home in Europe. Adametz and Dürst believe in a diphyletic origin, the ancestors being *primigenius* and *longifrons* and the homes of both in Asia; while Rütimeyer, Frantzius, Pagenstecker, Wilckens, Keller, and Ewart, though believing in a diphyletic or polyphyletic origin, think that at least the home of *longifrons* was in Africa or Asia.

II. EARLY HISTORY OF CATTLE BREEDING, AND CLASSIFICATION OF MODERN BREEDS.

THE CATTLE OF THE ANCIENT CIVILIZATIONS OF ASIA.

Recent explorations in Turkestan have thrown considerable light on the oldest civilization of which we have any record. In deposits of the oldest layers of Anau remains have been found of a wild species of ox, which is undoubtedly *Bos namadicus*, and for the present at least can be considered as the Asiatic form of *Bos primigenius*. The animal was wild, (1) because it was much larger than all the later domesticated bovine animals; (2) because the bones are heavier and harder than those of domesticated bovids; (3) because the bones of other species in the same layer belong undoubtedly to wild animals; and (4) because remains of this large animal are absent in the upper layers of the deposit. In the later deposits, about 8000 B. C., a domesticated longhorned ox appeared, which Dürst regards as a domesticated form of *namadicus*, identical with *Bos taurus macroceros* of Egypt, which was spread at a still later period by tribal migrations. Remains of a small-horned domesticated species occur as a more modern type and possibly may be a stunted form of *macroceros*, unless possibly a smaller bovid may have reached Anau with the other imported domesticated animals. Somewhat later a similar change from the large form to a small form took place in Mesopotamia and also in Europe, but whether it was a dwarfing of the larger species or the introduction of a new species is still an unanswerable question.

The ancient inhabitants of Persia, Babylonia, and Assyria also hunted a wild bovid, *Bubalus palæindicus* Falconer, or a more recent form of that Pleistocene species *Bubalus arnee* Kerr, the Indian buffalo, which is depicted on the cylinder seals of Assyrian kings. Large numbers of these animals were killed by the Assyrian King Ashurnasirpal on the hunting grounds near the Euphrates. Aristotle also mentions the occurrence of the buffalo with horns curved back to the neck in the Persian Province of Kohkand.

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Bos primigenius and *Bos priscus* (the Pleistocene bison) are also found fossil together in western Asia as well as in Europe. The bison was wild in Mesopotamia up to Assyrian times. Some teeth of *primigenius* have been found in the bone breccia of Lebanon, which prove it to be coexistent with man, and Dr. Schliemann found the remains of bones of *primigenius* at Troy.

It has been suggested that the unicorn referred to in the Bible down to the time of David may have been *Bos primigenius*, but another alternative is that the unicorn was a straight-horn antelope, which when seen in profile has the appearance of possessing only one horn.

The other domesticated animals of western Asia are much the same as those of Egypt. The zebu was domesticated probably as early as 4000 B. C., and spread from Asia to Africa, so that from very ancient times the distribution was much the same as to-day. Aristotle, Pliny, and Oppian knew of the zebu in Syria, and it may have gradually changed into the steppe breed. (Troltsch, 1902; Keller, 1902.)

THE CATTLE OF EGYPT.

The Egyptians loved their animals, but cattle were the most prized of all. Instead of the lion or the eagle, the bull was the symbol of power and craftiness. The highest goddess was worshiped in the form of a cow. Laborers gave their oxen pet names and conversed with them as we do with dogs. Decked with bright cloths and pretty fringes, cattle were highly esteemed as presents.

Between "ena," the common breed, and "neg," which was rare, we can see but little difference. Hartmann thought there were three breeds and made his division according to the shape of the horns—the lyre-form, the half-moon, and those in which the horns pointed away from each other. Dürst recognizes only the longhorned and the shorthorned, both of which came from Asia and were similar to the cattle of old Babylonia. Polled cattle and flap-horned cattle are there, but they are never represented as at work, so we may suppose them to be "fancy stock." The absence of horns may have been due to spontaneous variations from the other two breeds, but methods of preventing the growth of horns were known to these ancient cattle "jockies" or "fanciers." Sometimes one horn of the bull was bent down by shaving off the horn on the side on which the concavity was desired. This process was accelerated by the application of hot irons.

Dürst says that the humped cattle of Egypt are a variety of the shorthorned, but of a more recent date. They came from Syria, Nubia, and Somaliland, and may be the animal represented on monu-

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ments of the fourth dynasty, which, with the exception of the hump, resembles very much modern steppe breeds of eastern Europe.

At the beginning of the fourth dynasty, about 3000 B. C., the Egyptians had domesticated the cow, ass, goat, dog, pig, goose, and antelope (Troltsch). The horse was introduced during the time of the shepherd kings. Sheep, camels, buffaloes, cats, hens, and ducks were later additions. After sheep became common, antelopes and gazelles went out of favor.

CARTHAGINIAN AGRICULTURE.

Notwithstanding that Cicero says the weakness and downfall of Carthage was due to the neglect of arms and agriculture for trade and commerce, there is little doubt that during the height of prosperity agriculture was in good repute, as is witnessed by the writings of Mago and Hamilcar. When Carthage was sacked by the Romans but few books were preserved except those on agriculture. The counsels of Mago for the breaking of oxen to the plow have yet to be improved upon. His writings were the source of much of the information of most Roman writers on agricultural subjects. Most of the cattle of the Carthaginians were derived from the breeds of Egypt.

CATTLE OF PREHISTORIC EUROPE.

THE OLD STONE AGE.

The length of the European Palæolithic period, or stage of civilization in which cut-stone implements were used, can not be estimated with any accuracy. It occurred just before the last glacial epoch, and Mortillet estimates that it lasted many thousand years, while Baranski (1896) says it extended only from 4000 to 1000 B. C., and Müller (1897) thinks it ended in Denmark about 700 B. C. Undoubtedly it ended at a much later period in northern than in southern Europe. Man at that time was a hunter and fisherman, and had no domesticated animals until toward the close of the epoch. The Indo-Germanic invasion occurred, if at all, at about this time.

The Palæolithic shell heaps along the coast of the Cattegat contain bones of *Bos primigenius* and the European bison, which lived there wild at that time, at least 3000 B. C. There are some traces of a smaller ox, but no domesticated ox for certainty.

THE NEW STONE AGE.

At the beginning of the Neolithic or polished-stone period the change from savagery to barbarism was made. During this period it is the common belief that there was an invasion of Europe by people from Asia, who brought with them a few domesticated animals.

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Some of the pileworks in the Swiss lakes were erected at this time. Beautiful weapons, household utensils, and ornaments were made of flint and polished stones.

Traces of a domesticated dog are found, and before the close of the period probably the reindeer had been partially domesticated. In the pileworks of Switzerland are found bones of *Bos longifrons.*

In Denmark the Neolithic period extended from about 700 B. C. to 200 B. C. (Müller, 1897.) In Switzerland it began much earlier—extending from about 4000 to 2000 B. C., according to Troltsch. During this period we find cattle, sheep, goats, swine, and perhaps the horse, domesticated throughout northern and central Europe. Possibly some of the later shell heaps were formed about this time, but the most interesting and valuable of our data are from the pileworks about the lakes of Switzerland. Remains of these pileworks were often seen during low water in winter, though little notice was taken of them until Caspar Löhle, a peasant of Wangen, began to collect implements about these works in 1810. The exceptionally low water of the winter of 1853–54 exposed so much of the remains to view that Ferdinand Keller was led to make a careful study of these ancient lake dwellings. So far as our evidence now extends the oldest of these works were built at about the beginning of the new stone period either by the Aryans, who came from Asia, or by people who had borrowed their culture. The similarity of words, the domesticated animals, and cultivated plants, and the distribution of the pileworks, some of which extend as far east as Turkestan, lead to the inference that there may have been a migration. Until future anatomical studies of the different peoples decide the question we must remain uncertain as to whether the culture was borrowed or the people had migrated.

These lake dwellers had a knowledge of agriculture and cattle breeding. They grew wheat, six-rowed barley, millet, flax, caraway, weld, apples, and raspberries. They kept herds of cattle, goats, sheep, and swine. The flesh of the horse was eaten, but it is doubtful if the horse was domesticated at this time. Cattle were used as beasts of burden. Cows were milked and cheese and butter made. A dasher for churning butter was made from a portion of a tree with fasciculate branches, such as is used at the present time in the West Indies.

Bones of *Bos longifrons*, or the "little marsh cow," are very abundant, and this at a period possibly before Babylonian civilization (Dürst).

Bison and *Bos primigenius* are among the wild animals, but there is some evidence that the latter was tamed at this period, giving rise to several varieties. Apparently there were crosses between *Bos primigenius* and *Bos longifrons.*

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At Lattrigen, on the southern shore of Bieler Lake, are found what appear to be transitional forms between *Bos trochoceros* and *Bos frontosus*. Troltsch (1902) regards the domesticated primigenius forms as steppe cattle which came from Asia to Europe about 3000 B. C.

Rütimeyer (1862) divides the fauna found in the pilework into two periods. In the first, or age of primitive domesticated races, animal food was mostly obtained by hunting and fishing. The domesticated animals were the dog, sheep, goat, and two races of cattle, *Bos primigenius* and *Bos longifrons*. This period corresponds with the Stone ages of antiquarians. Remains at Wangen and Moosedorf, where there are no tame swine, represent the beginning, and those at Concise the end of the period.

The second period is the age of multiple races of the different animals and begins with the use of metals. Among the new races are the frontosus race of cattle, a larger dog, and a large and a small variety of hog. The period gradually changes to the present, which we may call the age of cultivated races.

THE BRONZE AGE.

At about the beginning of the Bronze age man was slowly advancing from barbarism to semicivilization. The number of domesticated plants and animals increased. In central Europe the lake dwellers were at the height of their development. Cattle breeding at this time held an important place in their industrial life. (Müller, 1897.) The cattle were smaller than the typical *Bos longifrons*, which Rütimeyer says may have been reduced in size by inbreeding. In some places, as at Morigen, sheep breeding was largely replacing cattle breeding. At this time the horse was domesticated, and before the end of the Bronze age the fowl from India was introduced (Troltsch). Recent excavations have uncovered works of art in the palace at Knossos, on the island of Crete, in which *Bos primigenius* is depicted as domesticated and used in bullfighting in pre-Mycenæan times. The Mycenæan age of Greece (about 1500 B. C.) was contemporary with the last of the lake dwellings.

ORIGIN OF THE CATTLE OF MODERN EUROPEAN COUNTRIES.

GREECE.

Neither the rocks of Arcadia, the swamps of Laconia and Acarnania, nor the droughts of Attica prevented the Greeks from successful tillage in the fertile spots of their mountainous peninsula. In Thessaly and Messenia the soil was fertile, and wheat, barley, wine, and oil were the chief agricultural products. Most of the pas-

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turage was poor; thus sheep and goats were more numerous than cattle. Yet there were white cattle in Thessaly, hornless cattle in Borysthenes, and a large breed of cattle, improved by Pyrrhus about 300 B. C., in Epirus. Pyrrhus selected breeding stock according to strict rules, and no heifers were allowed to breed until they were 4 years of age. Some of his cows gave 1½ amphorean (40 liters) of milk per day. Cheese, and probably butter, was made by the ancient Greeks. Arrian says that Alexander the Great imported 2,000 or more head of cattle from India (probably they were zebus).

Country life in Greece was dependent to a great degree upon social and political conditions. Constant risk of invasion compelled the people to live in or near the city walls. The rural arts were practiced by slaves and peasants, yet the science of agriculture was known to the educated, for Columella says that 50 agricultural treatises in Greek had been lost before his time.

ITALY.

Though the Indo-Germans led a pastoral life and knew the cereals only in a wild state at the time of the migration, the Greco-Italians were grain cultivators. We infer, then, that agriculture was adopted after leaving their original home and before settling in Italy and Greece. Italy was a land much better adapted for cattle raising than Greece. The Greeks referred to Italy as the land of cattle. Perhaps the word "Italy" was derived from the Greek word meaning "bull," although some philologists ascribe the origin of the word to "Italus," a mythical king in southern Italy who persuaded his people to turn from herding to tilling the soil. From the Roman laws we may infer that wealth first consisted of cattle and the usufruct of the soil (Mommsen).

Among the Romans the draft ox was considered invaluable, and to kill one was as serious a crime as to kill a man. White bulls were often offered as a sacrifice to the gods. Each Roman province had its own breed of cattle. In general, the different breeds, especially those of Lucania, Umbria, and Sabinia, were large and of the brachycephalus type, when it appears for the first time. In Campania and Siguria the cattle were smaller and of the longifrons type. Latium possessed a close-built, good working breed. The Apenine cattle were hardy but less comely. The smaller breeds in the valleys of northern Italy yielded a good flow of milk, which in the spring was considered a good medicine. Many Romans went to the herds of Switzerland for the cure of tuberculosis.

From Columella's description of the points of bulls, cows, and draft oxen, we may conclude that considerable attention was paid to selection of breeding animals. That cattle were bred in large numbers we know from the Punic Wars, when Hannibal captured 2,000 oxen

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and at one time offered up 300 white bulls as a sacrifice. At another time he escaped from a snare laid by Fabius Maximus by tying torches to oxen at night and driving them up the slope of the mountains. The Romans, thinking that the Carthaginians were escaping, started to head them off, but were met by an array of wild oxen. Hannibal easily escaped through a defile which was then left unguarded.

Cattle breeding in Italy was influenced by breeding stock which was carried from Epirus in Greece to Lucania. Keller (1902) says that these were of primigenius type, whereas Kramer (1899) does not see *primigenius* represented by any Roman artist.

In northern Italy and Switzerland the larger breeds were spoken of as Celtic cattle. Kramer (1899) thinks the Celts did not bring their cattle with them. When Cæsar defeated the Helvetians in the battle of Bibrachte all of their property was destroyed. After that these brachycephalus types, which were the result of breeding and which the Celts did not know, were taken by the Romans into Switzerland. Like the Roman goat, this type of cattle was carried in two directions, one to the valley of Wallis in west Switzerland and the other to the Duxer and Ziller Valleys in the east. In excavating for a railroad from Lyons to Vaugneray in 1885 many bones of cattle were found among the remains of the Roman village of Lugdunsian, which were of the longifrons type (Cornevin, 1885; Mortillet, 1890). In the Celtic deposits of Liggenthal only *longifrons* and *primigenius* are found. Roman cattle were also taken to England, as we shall see later.

GAUL.

In very ancient times, along the continental shores of the English channel (northwestern France and the Netherlands), the people had cattle of the longifrons type. Farther east the people then living between the Danube and the Alps possessed large and strong cattle that must have been of the primigenius type. The color of these cattle was red with white markings. We may consider this breed as the progenitor of the modern breed of Salers, France. In the meantime the original breed had been crossed with *Bos brachycephalus*, and the resulting cross was known as the "Celtic red."

About the middle of the fourth century the Salie Franks entered Gaul and after much fighting settled in the northeastern part, bringing their large cattle with them. Thus the native *longifrons* was supplanted by the westward march of *primigenius*. Before the close of the next century the remainder of Gaul had been conquered, though but few cattle were introduced (Werner).

IBERIA.

Before the Aryan invasion the people of the Iberian peninsula (Spain and Portugal) had a variety of *brachycephalus* cattle. These

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cattle were also in north Africa, Corsica, Sardinia, and France. Modern representatives are in Spain to-day. They gradually spread to the east and deviated from the common type. According to Werner the Celts brought primigenius breeds to Iberia and crossed them with the native stock, giving rise to the breeds now known as Brittany of France, Kerry of Ireland, the Welsh Black, Devon, Hereford, and Longhorn of Great Britain, the Duxer and Pinzgauer of southern Germany, and the Piedmont breeds of northern Italy. Kramer (1899) thinks that the Celts did not take their cattle with them as they migrated. It is quite certain that the Celtic breeds had little effect in changing the Iberian native stock.

SWITZERLAND.

Werner states that the aboriginal Swiss cattle were black with white spots, now represented by the short-headed Vogesen and the Freibourg black spotted, but that the latter has lost the short-headed character in crossing.

When the Burgundians settled in west Switzerland in 443 A. D., a new breed of the frontosus type was introduced to Switzerland. According to Ptolemy and Pliny the Burgundians previously lived near the Rivers Vistula and Spree. Some later evidence points to south Sweden as their home. In the Icelandic Edda (written probably about the twelfth century) the island of "Bornholm" is called "Borgundarholm."

It is well to note that *frontosus* was first found in south Sweden. A study of this type may furnish some decisive evidence as to the original home of the Burgundians. The cattle in the mountains of Switzerland still retain the longifrons characteristics, and the improved breeds, like the well-known Brown Swiss, are a result of careful selection ever since the pileworkers lived in that vicinity. (For a history of this breed, see Ringholz, 1908.)

RUSSIA.

Herodotus writes of the polled cattle of the Scythians, in what is now southern Russia, about 500 B. C. Werner says that these Scythians had a breed of brown cattle with long horns, and hornless zebus, as well as crosses between the two. Middendorf finds small hornless breeds in the woods of southern Russia which correspond to the Scythian cattle of Herodotus, and also says that the polled primigenius breeds of northern Russia came from this Scythian stock. In Finland and northern Russia the cattle are small but of primigenius type. The Cholmogory breed of northern Russia was a cross of the native cattle with improved breeds from Holland.

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GERMANY.

From Tacitus and other classic authors we learn that in the land of the Germans there were many cattle, which were small, though of the primigenius type.

It abounds in flocks and herds, but in general of a small breed. Even the beef kind are destitute of their usual stateliness and dignity of head; they are, however, numerous, and form the most esteemed, and indeed the only species of wealth. * * *

Homicide is atoned by a certain fine in cattle and sheep. * * *

Their food is simple; wild fruits, fresh evening or coagulated milk. [A note says this is not cheese, although Cæsar says "their diet consists of milk, cheese, and flesh."]

Pliny says:

It is surprising that the barbarous nations who live on milk should for so many ages have been ignorant, or have rejected the preparation of cheese, especially since they thicken their milk into a pleasant tart substance, and a fat butter; this is the scum of milk of a thicker consistency than what is called whey. It must not be omitted that it has the properties of oil, and is used as an unguent by all the barbarians and by us for children. (XI, 41.)

Cæsar says the Germans were not studious of agriculture. A cross of the *primigenius* of the old Teutons took place with *longifrons*, which is seen in the lowland breeds of Germany to-day. At the beginning of the fifth century the Allemanni went from south Germany to east Switzerland, carrying the red Celtic *brachycephalus* and crossed it with *longifrons*, giving rise to the Algaüer breed. The yellow breed of Oberinthaler may also have arisen in a similar manner after the Gauls entered Rhetia (Werner).

In northwestern Germany the cattle are similar to those of the Netherlands, while in the southern part they are more like the cattle of Switzerland. In the middle part of the empire are a variety of breeds which are little known outside of their native districts, so that any detailed description of them here must be omitted. A few representatives of the Simmenthal breed, a beautiful modern type of *frontosus*, have been brought to the United States.

A detailed description of German breeds may be found in the works of Dr. Hugo Werner and other German authors. (See also "Cattle and Dairy Farming," United States Consular Reports, 2 vols., 1887.)

THE NETHERLANDS.

The oldest inhabitants of Holland of which we have any records are the Friesians, who dwelt on the shores of the North Sea as early as 300 B. C. They were a peaceable, pastoral people and may have originally migrated from central or western Asia. Little is known concerning the characteristics of their cattle, but it is certain that a portion of them were white and that they were of some religious sig-

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nificance. Two hundred years later another German tribe, the Batavians, came down the Rhine from Hesse and settled near the Friesians, where they drained marshy lands and islands, built dikes, and had numerous herds of large, longhorned black cattle of the primigenius type, which in all probability they had brought from their former home. Since that time cattle-keeping has been the chief occupation of these people when not engaged in defending themselves against the onslaughts of the Normans, Jutes, Angles, and other quarrelsome neighbors.

Referring to a more recent period, Motley, the historian, says:

> On that scrap of solid ground rescued by human energy from the ocean were the most fertile pastures in the world; an ox often weighed 2,000 pounds, the cows produced two and three calves at a time, and the sheep four and five lambs. In a single village 4,000 kine were counted. Butter and cheese were exported to the annual value of $1,000,000, salted provisions to an incredible extent. The farmers were industrious, thriving, and independent.

So fertile were the lands in this region that during the twelfth and thirteenth centuries a tide of emigration set in that direction from neighboring lands less fitted for the grazing and rearing of cattle. The first cattle market in that vicinity was at Hoorn, which was established as early as 1311 A. D. Bakker's recent study of the origin of the cattle in Holland leads to the conclusion that the original color was red and that the black color came from Jutland cattle imported in the latter part of the eighteenth century.

As a good cattle land Holstein is of somewhat later date than the Netherlands. Many colonists went from Friesland, Holland, and Westphalia and settled in Holstein, taking cattle along with them (Hengeweld). By far the larger number of cattle in this region are black-and-white in color, large in size, and noted for giving large quantities of milk. Those in Holland may be considered the most typical of the breed. Many subbreeds, some of them red in color, have been derived from the principal type and are designated by some local geographical name. It is a misnomer to call the breed Holstein, which is only a subbreed, or even Holstein-Friesian, a name adopted by the breeders of these cattle in the United States. The native farmers use the term "Dutch" to designate the cattle, which is more appropriate; as also the "Nederlandish," and "Hollandaise," used respectively by the Germans and French.

In the seventeenth and eighteenth centuries large numbers of Netherlands cattle were imported to the British Isles, most of them going to the district of Holderness and the fertile district of the Tees. Peter the Great imported some to Russia and crossed them with natives, and from the cross has resulted the Cholmogorian breed. In the last two decades of the nineteenth century large numbers of Dutch cattle were imported to the United States.

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SCANDINAVIA.

From the ancient Sagas we learn that there were two breeds of cattle in Scandinavia. One was a small white or white-spotted, hornless breed living among the mountains in north Sweden; the other was a large black breed similar to the cattle of Jutland and Denmark. At the entrance of the Goths there was another highly prized, large-horned breed, either red or yellow in color, which appears to have been introduced by them. The Vikings were in the habit of taking their cattle with them on shipboard, and the Norwegian settlers in Iceland in 874 brought their cattle along with them (Malet, "Northern Antiquities"). Thorsin, the Icelander who founded a colony in Vinland, carried cattle with him.

Sundbärg, referring to the cattle of Sweden, says:

> The history of the cattle in our country presents a good many vicissitudes. The law of Uppland, A. D. 1296, describes Swedish cattle as being small, hornless, white or whitish gray, often with dark spots. The Alpine breed in northern Sweden is so still, a race we have every reason to consider as being the oldest in the country.

In the sixteenth century King Gustav I imported breeds from Jutland and Holland. Since then many importations have been made from the lowlands. The famous Thelemarken breed of Southern Norway is a direct descendant of *Bos frontosus*.

DENMARK.

In Denmark there are principally two breeds, the black-and-white breed of Jutland, with an origin similar to that of the Holland cattle, and the Red Danish, a breed whose origin is about the same as the red breed in Schleswig. Both of these have gradually evolved from the native breeds which have been in that vicinity since the dawn of history. Many of the English breeds, especially Shorthorns, have been introduced into Denmark, and, according to Rasmussen, have had an important influence in the development of Denmark from a grain-growing to a cattle country, not so much by the infusion of new blood, as by giving the farmers an ideal as to form and teaching them the importance of good feed and care in the rearing of cattle.

FRANCE.

The French eat much less beef than the English, and thus their breeds of cattle have been developed for the dairy and for draft purposes rather than for meat. The largest and most popular general-purpose breed is the Normandy, a descendant of *Bos primigenius*. There are several subbreeds—one of them, the Cotentine, has been bred mainly for milk, and another, the Augeronne, for beef. The

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heavy-milking Charolais breed, white in color, is presumably a modern type of *Bos frontosus.* The Nivernais, a subbreed, is probably a cross between the English Shorthorn and the Charolais. The Flamande breed in northeastern France, whose origin is similar to that of the Dutch cattle, is divided into a great many subbreeds, some of which are famous for milk production.

The Limousine breed, of Celtic shorthorn type, is one of the best beef breeds of France, although not so large as many others. Breeds of southwestern France resemble the Iberian breeds, and those of the southeastern part are more like the Swiss cattle.

Besides the native breeds there have been many importations of Shorthorns into northern France, as well as some Jerseys and Holsteins. (For detailed descriptions of French breeds see Werner, De Lapparent, and United States Consular Reports.)

GREAT BRITAIN.

Abundant remains of *Bison priscus* and *Bos primigenius* appear in Pleistocene strata in Great Britain. Both continued to live there for a long time. The bison disappeared first, while *primigenius* continued through the Neolithic period and possibly in the mountain fastnesses until within historic times.

But a short time elapsed between the last of the lake dwellers in Switzerland and Cæsar's entrance into Great Britain, which was then in the pastoral stage, but during the Roman occupation the inhabitants began to pay more attention to the cultivation of plants. Cæsar found large herds of domesticated cattle, but they were evidently of the longifrons type, which was abundant during the Bronze age. The remains reveal a small breed about the size of the Irish Kerry. The small horns were sharply curved forward. Excavations show that since that time the native breed was gradually modified and increased in size with an outward and upward curve of horns. Hughes (1894 and 1896) says these changes could not come about by a cross with primigenius breeds.

Sculptures, coins, and mural paintings of Roman cattle are represented with upturned horns much like some Italian breeds of to-day. Other Italian breeds have horns growing outward. Reasoning from these premises, Hughes thinks that cattle were carried from Italy to England during the Roman occupation and crossed with the native *longifrons.* The semiwild cattle now roaming in the parks of Great Britain resemble the Sicilian and ancient Roman breeds. As Roman cattle were also one variety of *longifrons*, it would appear that the early breeds of Britain were exclusively of the longifrons type. The only alternative is the question as to whether or not *longifrons* is itself a stunted form of *primigenius.*

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Another modification of British cattle began when longhorned cattle, of primigenius descent, were introduced from Jutland, Friesland, and the Lower Elbe. Grant Allen, in "Anglo-Saxon Britain" (p. 14), says:

The early English in Sleswick and Friesland had partially reached the agricultural stage of civilization. They tilled little plots of ground in the forest; but they depended more largely for subsistence upon their cattle, and they were also hunters and trappers in the great belts of woodland or marsh which everywhere surrounded their isolated villages. They were acquainted with the use of bronze from the first period of their settlement in Europe.

The wealth of the people consisted mainly in cattle, which fed on the pasture, and pigs turned out to fatten on the acorns of the forest; but a small portion of the soil was plowed and sown, and this portion also was distributed to the villagers for tillage by annual arrangement.

The Saxons probably brought their cattle with them to England, while the Celts retreated with their shorthorned *longifrons* to the mountains of Scotland and Wales. The descendants of these cattle have furnished the foundation stock of modern breeds in those districts. Later introductions from Normandy and northern Germany have modified the breeds in the eastern and southern countries. Hughes cites the Kerry as the modern breed most typical of the old Celtic Shorthorn, the Highland and Welsh breeds of the cross between the Celtic Shorthorn and Roman cattle, and the longhorn breed as the most typical of the result of a cross with the breeds of the lowlands on the Continent.

It is the general opinion at the present time that the white Park cattle are descendants of some domesticated white breed which have become feral. Wilson believes that all hornless breeds of the British Isles can be traced to a Scandinavian origin, but this does not account for the hornless wild cattle nor the hornless skulls found in the Roman fort at Newstead.

Ewart (1911) finds four distinct types of horned oxen at Newstead, namely, *longifrons*, *primigenius*, *acutifrons*, and a type with a convex forehead and rounded poll resembling *namadicus* rather than *primigenius*. There were also flat-polled and round-polled types of hornless oxen.

IRELAND.

The native cattle of Ireland are presumably descendants of the wild forest breed, as they have characteristics resembling the Welsh and Highland cattle. The remains of *Bos longifrons* are also abundant. At Uriconium, which for a long time was the headquarters of the Roman Twentieth Legion, remains of *frontosus* have been found (Blyth, 1864).

Females were more abundant than the males, an indication that they were domesticated. The oldest annals of Ireland refer to horned cattle, but for a long period hornless cattle also have been quite numerous,

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CHANNEL ISLANDS.

It has often been stated that the cattle of the four islands of Jersey, Guernsey, Alderney, and Sark originally came from Normandy, yet most naturalists place Normandy cattle in the primigenius group, while the Channel Islands cattle, the Brittanies, and the Kerries are regarded as descendants of *Bos longifrons*. In our opinion this is the most likely supposition, although no doubt there has been some admixture of Norman blood, especially in the Guernsey cattle.

The deerlike form and color of the Jerseys indicates unmistakably longifrons blood. The cattle of the other islands, by their color, length of leg, and larger body, show a closer resemblance to the Norman cattle, which would be likely, as laws restricting importations of cattle have been less stringent than in the island of Jersey, where no foreign breed has been imported for about 125 years.

ORIGIN OF THE PRINCIPAL TYPES OF CATTLE IN AMERICA.

The first cattle in America were brought in 1493 by Columbus on his second voyage. Subsequently many other cattle were brought from Spain to the New World by the colonists who settled in the West Indies. Some of the cattle escaped from captivity and lived in a wild state where there were rich grazing lands in the wilds of the Antilles. From the West India Islands these cattle of Spanish descent were carried to the mainland both north and south of the Isthmus of Panama. About 1525 some were taken to Vera Cruz, Mexico, where they rapidly multiplied and gave rise to the stock which later became known to the breeders in the United States as "Texas" cattle, and hence are of Spanish origin as well as those of South America.

The Portuguese made settlements at Cape Breton Island and other places, as an adjunct to the fishing industry, about 1525, or even earlier. Both cattle and swine were taken by the fishermen to Newfoundland and Nova Scotia in 1553. In 1604 Lescarbot, a French lawyer, carried cattle to Arcadia. Five years later he wrote a history of New France, wherein he states that in 1508 or thereabouts Baron de Lery attempted a settlement at Sable Island, and the cattle found many years later on the island are supposed to be descendants of De Lery's stock. When the Huguenots settled, in 1672, on the Broad River, S. C., they may have taken cattle with them, but up to the present time we have found no record to that effect.

The first cattle to reach the territory now included in the United States were brought by Sir Richard Grenville to Virginia in 1535, in an expedition sent out by Sir Walter Raleigh, which left Plymouth, England, on April 9, but the colony perished and the cattle were probably slaughtered by the settlers. From an exhaustive study

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of the records[1] it is evident that the cattle introduced at Jamestown, Va., were from English breeds, with some mixture of Spanish cattle from the West Indies. In New York the cattle were largely of Dutch origin. In Pennsylvania the cattle were brought over by the Dutch and Swedish settlers. At Plymouth, Mass., the cattle were brought from Holland and England. The ships which arrived at Boston contained mostly English breeds, the Devon predominating. In New Hampshire Capt. Mason introduced a large yellow breed from Denmark. In Canada the importations were largely from France.

In the West Indies, Mexico, and Central and South America the cattle were nearly all from Spanish stock until within recent years. Many good breeding animals from improved breeds have been imported from Europe and the United States to Argentina and other countries of South and Central America during the past 50 years. Humped cattle of India (zebus) have also been imported to Texas and the West Indies, because of their supposed immunity from Texas fever, and the crosses with native cows have thus far been very successful.

Although we speak of the different breeds of cattle that were brought to America, there were many nondescripts, and but few if any would be recognized as belonging to any type of our modern purebreds until Messrs. Miller and Gough imported what were supposed to be pure Shorthorns in 1783. With the exception of the Holsteins and the Brown Swiss, but few cattle from other countries have been imported except from the British Islands.

Cattle not being native to America, there are no strictly American breeds, but, owing to differences in climate, care, and ideals of American breeders, the European breeds which have been brought to America have nevertheless changed to some extent. Occasionally a strain of improved stock has arisen as a sport, or by careful selection of the stock has obtained a local reputation as a breed, such as the Gore breed, well known in New England 75 years ago, and still later the American Holderness in New York; but, up to the present time, with the exception of the Polled Durham and the French-Canadian, none of the so-called American breeds has obtained anything like a national reputation.

CLASSIFICATION OF MODERN BREEDS.

Early classifications of breeds were based upon their geographical distribution. Sturm, in 1825, gave the classification of lowland, upland, and mountain breeds. Later, the factor of color was taken

[1] The results of a study of the early importations of cattle in America and cattle breeding in colonial times will be given more in detail in a later paper.

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into consideration. A half century ago the cattle in Great Britain were divided into shorthorns, middlehorns, and longhorns. To-day, English and American writers arrange them according to their economic value as beef breeds, dairy breeds, and general-purpose cattle, while the Germans make physiographical factors an important consideration, as Krafft, who made seven divisions, namely, steppe, lowland, solid-colored mountain, spotted valley, upland, English, and French breeds. Wagner (1837) was the first to rely upon osteological characters. His two classes were arranged according to the curvature of the vertebral column: (1) *Taurus hypselurus—cauda altissima posita*, and (2) *Taurus frisius—cauda profunda posito*—a questionable division.

Sanson, following the methods of the anthropologists, divided cattle into two groups, the dolichocephalic or long-headed, and the brachycephalic or broad-headed. These two groups he subdivided again, making four subspecies or races. These were: (1) *Bos taurus ligeriensis*, (2) *Bos taurus jurassicus*, (3) *Bos taurus batavicus*, and (4) *Bos taurus alpinus;* the first two being brachycephalic and the two latter dolichocephalic.

1. *Ligeriensis* is found to-day from the mouth of the Loire to that of the Gironde, and in characteristics this race resembles *primigenius.*

2. *Jurassicus* includes *trochoceros* of Meyer and *frontosus* of Nilsson. Its representatives are found in the cattle of Berne and Freiburg, and the breeds in France known as Bressane, Comtoire, Femeline, and Charolais.

3. *Batavicus* is equivalent to *longifrons* of northern Europe.

4. *Alpinus* is the *longifrons* of Switzerland, now generally known as the Brown Swiss breed. What Wilckens calls *brachycephalus*, Sanson would probably consider a cross between *jurassicus* and *batavicus.*

Rütimeyer (1862) was the first to propose a classification based essentially upon zoological characteristics alone, but would include geographical, historical, and geological evidence. It may be called a paleontological classification. His system has been followed more or less closely by all later German authors. He made three races.

1. The primigenius race, which included Holland, Friesland, Oldenburg, Roman, and Podolian breeds, and the white Park cattle of Great Britain.

2. The brachyceros race, which included the Brown Swiss cattle of Switzerland, Uri Wallis, Oberbasle, and Graubünden, and the cattle of Algeria.

3. The frontosus race, which included the spotted cattle of Simmenthal and Saanenthal and the hornless cattle in the mountains of Norway.

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The Freiburg breed he considered a cross between the last two races.

Werner (1902) and Wilckens make four groups, *primigenius*, *frontosus*, *brachyceros* (*longifrons*), and *brachycephalus*. Müller (1900) adds a fifth to the four above mentioned and calls it the Highland breed.

Keller's classification (1902 and 1905) is as follows:

1. *Bos primigenius*, whose home is in Europe, includes the English Park cattle, the North German, Lowland, Dutch, Steppe, Simmenthaler, and Freiburg spotted breeds.

2. *Bos sondaicus*, whose original home was in Java, includes the Asiatic and African zebu, Old Egyptian Longhorn, Algerian, marsh cow of the lake dwellers, Albanian, Sardinian, Spanish, Polish, Channel Islands, Hornless Fjell, and Brown Swiss breeds.

Adametz (1898) recognizes two main types of domesticated cattle. From the first, which he calls *Bos taurus primigenius*, and whose ancestor was *Bos primigenius*, he finds four races: (1) Steppe cattle; (2) primigenius mountain cattle, as the breed of Auvergne; (3) primigenius lowland, pure as in Normandy, less pure in the Holland, Oldenburg, and East Friesland red breeds; (4) Swiss spotted or Alpine breeds with a broad forehead (*frontosus*).

His second type is *Bos taurus europeus*, with *Bos brachyceros* (*longifrons*) as the ancestor, represented in five modern races. The first race is typical of the ancestor, and is represented by old marsh cow, the Jersey, Brittany, Illyrian, Albanian, and other similar breeds. The second race is polled; examples are found in Scotland, Sweden, Lapland, and Russia. The third race is of longifrons type, though having become somewhat larger through care and a favorable climate. Brown Swiss is a typical example. The fourth race is represented by Tuxer and Zillerthaler, which are pug-nosed variations of *longifrons*. The fifth race, which he calls pseudo-primigenius, is a result of crossing other types, and is represented by Ayrshire, West Highland, and English Park cattle.

The most ambitious attempt to classify and describe all varieties of cattle is that in Werner's "Rinderzucht," to which the reader is referred for details, it being too long to be given here.

Lydekker (1904) classifies British cattle according to color, making three groups, as follows:

1. Pembroke and Park cattle, either black or white; the black being descendants of forest-dwelling animals, and the white, sports.

2. Spanish and Channel Island cattle, that vary from black to fawn, both primitive colors.

3. Shorthorn, Devon, Hereford, in which black is lost and being the most marked departure from the primitive types.

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A CLASSIFICATION OF BRITISH CATTLE.

McConnell makes three types of cattle in the British Isles, namely, *longifrons*, *primigenius*, and mixed:

Bos longifrons type.

Sutherland.	Anglesea.	Cornish Black.
North Highland.	Carnarvon.	Jersey.
Kintail.	Cardigan	Guernsey.
Kyloe.	Carmarthen.	Alderney.
Skye.	Pembroke.	Irish Moyle.
Galloway.	Merinoneth.	Kerry.
Cumberland.	Brecon Black.	

Bos primigenius type.

Cadzow.	Lincoln Red.	Sussex.
Chillingham.	Lincoln Dutch.	Dorset.
Chartley.	Craven Longhorn.	Glamorgan.
Fife (Falkland).	Derby Longhorn.	Castlemartin Black.
Shorthorn.	Stafford Longhorn.	Castlemartin White.
Teeswater.	Suffolk Dun.	Irish Longhorn.
Holderness.	Hereford.	

Mixed type.

Shetland.	Ayrshire.	Montgomeryshire-Smokyface.
Orkney.	Lothian.	Old Gloucester.
Banff.	Ettrick.	North Devon.
Aberdeen Horned.	Yorkshire Polled.	South Devon.
Buchan Humlie.	Yorkshire Middlehorn.	Irish Middlehorn.
Angus Doddie.	Norfolk Horned.	
Forfar Horned.	Red Polled.	
Argyle (South Highland).	Shropshire.	

In our opinion the Galloway, Glamorgan, Guernsey, and possibly others should be classed with the mixed type.

A CLASSIFICATION OF FRENCH BREEDS.

The following is a classification of French breeds modified from Werner:

Bos primigenius germanicus var. *flandricus.*
- Flamande.
- Ardennaise or Meusienne.
- Wallone.

Bos primigenius germanicus var. *normannus.*
- Normande.

Bos longifrons alpestris var. *flavus.*
- Tarentaise.

Bos longifrons ligeriensis (Sanson).
- Parthenaise (including Poitevine, Mantaise, Vendée, and Marchoise).

Bos longifrons vasconiensis.
- Gasconne.
- Bazadaise.
- D'Aure (St. Giron and Ariegeoise).

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Bos frontosus fronconicus.
Fémeline.
Charolaise (Nivernaise).
De Sans (Du Mézenc).
De Lourdes.
Bos brachycephalus isolanus.
Carmargue.
Béarnaise (Basquaise, D'Urt).
Landaise.
Bos brachycephalus aquitanicus.
Garonnaise.
Agenaise.
Limousine.
Bos brachycephalus celticus.
Bretonne.
Bos brachycephalus alverniensis.
De Salers (Du Cantal).
Du Puy de Dôrne.

CLASSIFICATION OF BREEDS IN AMERICA.

As in England, the breeds of cattle in America are usually classified according to their uses into beef, dairy, and dual-purpose breeds. Hitherto, no attempt has been made to classify them according to their ancestry, but by following Werner's arrangement of types we have the following provisional classification, which includes the breeds which have originated in America as well as those which have been imported. In but few cases, however, are they true to the types, because of much intercrossing.

1. *Bos primigenius germanicus.*
Holstein-Friesian.
Dutch Belted.
Yellow Danish.
Bos primigenius germanicus var. *normannus.*
Normandy.
Bos primigenius germanicus var. *anglo-saxonicus.*
Shorthorn.
Polled Durham.
American Holderness.
Red Polled.
2. *Bos primigenius scoticus.*
West Highland.
Galloway.
Aberdeen-Angus.
Ayrshire (crossed with *longifrons*).
3. *Bos longifrons alpestris* var. *brunneus.*
Brown Swiss.
4. *Bos longifrons isolanus.*
Jersey.
Polled Jersey.
Guernsey (crossed with *primigenius*).

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5. *Bos frontosus burgundicus.*
   Simmenthal.
   Mixed breeds from Sweden.
6. *Bos brachycephalus ibericus.*
   Texas.
   Guinea.
7. *Bos brachycephalus celticus.*
   North Wales.
   Kerry.
   Jamestown.
   Brittany.
   French-Canadian.
8. *Bos brachycephalus licestriensis.*
   Longhorn.
9. *Bos brachycephalus britannicus.*
   Hereford.
   Polled Hereford.
   Kansan.
   Sussex.
   Devon.
   Polled Devon.
10. *Bos indicus.*
    Zebu.
11. *Bos bison* ×, *Bos primigenius scoticus.*
    Cattalo.

This arrangement is faulty in many respects and can not be accepted as it now stands. The longhorn breed is presumably of the primigenius type, with possibly some mixture of longifrons blood. The Hereford, Polled Hereford, and Kansan have about the same origin as the Normandy breed. Probably the Ayrshire, West Highland, and Galloway have more longifrons blood than primigenius, while the Kerry and Brittany are more like *longifrons* than *brachycephalus.*

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STATE AND MUNICIPAL MEAT INSPECTION AND MUNICIPAL SLAUGHTERHOUSES.

By A. D. Melvin, D. V. S.,
Chief of the Bureau of Animal Industry.

It is estimated that a little more than one-half of the total meat supply of the United States comes under the inspection of the Federal Government. Most of the remainder receives no inspection whatever, while a portion is subjected to a limited inspection by State or local officers.

The principal object of meat inspection is to protect the consumer from diseased or otherwise unwholesome meat. This involves not only the inspection of the meat for the detection of disease or other unwholesome conditions but the requirement of sanitary conditions and equipment in the abattoirs and packing houses and the enforcement of sanitary methods in the preparation, curing, and handling of the meat. To meet the first requirement there should be a competent veterinary inspection of the carcass at the time of slaughter, or, in case inspection at the time of slaughter is impracticable, the inspection may be performed later if certain viscera are retained with the carcass. Too often the local meat-inspection service, where it exists at all, does not provide for an inspection of this kind, but consists merely in the inspection of the meat as it is offered for sale in the markets, with sometimes a sanitary supervision of the markets. Although such inspection has some value, it is far less important than the veterinary inspection of the carcass at the time of slaughter. The average consumer is able to determine for himself whether or not meat is tainted or spoiled, but he is not able to determine for himself whether or not it comes from an animal affected with a contagious disease. Neither can even a skilled inspector always detect disease in meat after it has been dressed and the viscera disposed of. The most important requirement in meat inspection, therefore, is to protect the consumer against dangers from which he can not protect himself, and this can be done only by a class of inspection that is not often provided for by local authorities.

THE NEED FOR LOCAL INSPECTION.

The Federal meat-inspection system depends for its authority upon what is known as the interstate and foreign commerce clause of the Constitution of the United States, and this inspection is there-

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fore limited to the product of establishments that are engaged in interstate or foreign commerce. The Federal Government is powerless to exercise any supervision over an establishment the meat of which is slaughtered, prepared, sold, and consumed entirely within a single State. It is a duty which the State or the municipality owes to its citizens to install and maintain a system of meat inspection that will afford adequate protection against diseased and unwholesome meats, so that all meat sold locally which has not passed the Federal inspection will come under the requirements of an efficient local inspection system.

Some idea of the necessity for this local inspection may be obtained by considering the extent of disease among live stock slaughtered for food, and the insanitary conditions under which much of the local meat supply is slaughtered and handled. Recent statistics of the Federal inspection show that nearly 2 per cent of the carcasses are affected with some disease or condition making it necessary to condemn them either in whole or in part. Of these condemnations nearly 87 per cent are due to tuberculosis alone. We find that about 1 per cent of the cattle and over 2 per cent of the hogs slaughtered under Federal inspection are affected with this disease to a greater or less extent. The establishments under Federal inspection draw a large proportion of their cattle from the ranges and feed lots of the West, where tuberculosis is rare, hence the percentage of this disease found in the Federal service is far below that which occurs in animals from the dairy regions, where the disease is much more prevalent. It is estimated that at least 10 per cent of the dairy cows in this country are affected with tuberculosis, and it is a well-known fact that dairy stock forms a much larger proportion of the animals killed at the small local slaughterhouses than at the large establishments under Federal inspection. One effect of the Federal inspection has been to cause the owners of diseased or suspicious-looking animals to send them for slaughter to an uninspected place rather than to an establishment where they would have to run the gantlet of strict inspection. For these reasons it is certain that the percentage of disease is considerably higher among animals slaughtered at the small local places than among those slaughtered under Federal inspection.

Uninspected slaughterhouses as a rule have many features that are not only objectionable but dangerous to health. The smell of the country slaughterhouse is proverbial, and the conditions at some of these places are inexpressibly foul and filthy. They are usually located in some out-of-the-way place, sometimes outside the corporate limits, often surrounded by stables or even being a part of a building which is also used as a stable, barn, or for some such purpose. Sometimes they are located on the banks of small streams and

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pollute the water. Such places are often the means of spreading disease. It is frequently the custom to feed offal to hogs or to throw it where dogs, hogs, and rats have access to it. By this means trichinæ, tapeworms, and other animal parasites are disseminated, some of which are dangerous to man. Hog cholera, tuberculosis, and other contagious diseases may also be spread by such conditions. Usually there is no protection to the meat against rats, flies, and other insects and vermin, and this condition constitutes a dangerous source of contamination and infection.

The objectionable conditions are not confined to the little slaughterhouses in small communities. Even in some of the large cities there are large abattoirs which do a purely local business and at which the conditions and methods are exceedingly insanitary and where a very poor class of live stock is slaughtered.

PROBLEMS OF LOCAL INSPECTION.

In planning and executing State or municipal inspection much can be learned from the methods of the Federal meat-inspection service, although local inspection in small communities presents certain difficulties and problems not found in the Federal service. The objects to be gained and the principles to be applied are the same in each case, but the different conditions sometimes require different methods. The Federal inspection has been in operation for nearly 20 years, and for the last 4 years of this period it has been conducted under the new law, which confers authority and appropriates funds sufficient to make it much more comprehensive and efficient than in previous years. Most of the establishments under Federal inspection are large and are grouped at stock centers, although there are quite a number of smaller isolated establishments. The local authorities must often deal with small, scattered, poorly equipped, and very insanitary slaughterhouses, and it is sometimes out of the question to require the reconstruction of the buildings and the installation of expensive equipment in order to bring about a proper sanitary condition.

There are two main problems in an efficient system of local meat inspection. The first relates to the location, construction, equipment, and management of the slaughterhouses, and the second to the administration of the inspection service.

A MUNICIPAL OR CENTRAL SLAUGHTERHOUSE.

It is both difficult and expensive to supervise slaughtering at a number of small, isolated establishments, each killing only a few head of animals a day, or perhaps slaughtering only once or twice or three times a week. It is therefore desirable to concentrate the slaughtering for each community into one place. There should be a

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public slaughterhouse under either municipal or private ownership, and in either case under official supervision. Municipal abattoirs are quite common in Europe and have been found to be an exceedingly satisfactory method of enforcing an efficient inspection, but such abattoirs are very few in this country. Aside from facilitating inspection and making it more economical, central abattoirs afford commercial advantages. They provide machinery, facilities, and equipment such as are found in the large packing houses and which are not otherwise available to the small butchers. There is also economy in the cost of operation of a central abattoir as compared with the cost of a number of scattered places, and there is an opportunity to obtain revenue from by-products which are usually wasted at small establishments.

It is preferable for the town to build and own the abattoir and to require all slaughtering to be done there, except where conditions are such as to justify private plants and where inspection is already in effect at such plants or can readily be applied. Where it is not practicable for the municipality to own and operate an abattoir the next best plan is to have a central public abattoir owned and operated by private enterprise, and in that case the plant should of course be under an official inspection system.

The expense of building a municipal plant could very well be met by an issue of bonds, and a sinking fund for the payment of these bonds could be created by setting aside a portion of the revenue. There should be a system of fees or charges to provide an income sufficient to pay the cost of operating and maintaining the abattoir and the cost of inspection, and to meet interest and provide a sinking fund in case bonds have been issued. A certain sum per head could be charged for killing in case the entire operations were carried on by the management of the abattoir, or the butchers could be permitted to bring their stock to the abattoir and do the work there themselves by paying a certain sum per head for this privilege.

Where the slaughtering is done at a central place the system of inspection used in the Federal service can very easily be adopted,[1] but where there is very little slaughtering, and this is done at different points, it is a difficult problem to work out a system of inspection that will be efficient and not too expensive.

THE INSPECTION FORCE AND SOME FEATURES OF INSPECTION.

It is very desirable to have the inspection done by veterinarians whenever possible. A man who is a graduate of a good veterinary college is not only specially trained to recognize animal diseases, but also has a good knowledge of the danger of such diseases to

[1] For a description of the Federal inspection system the reader is referred to Bureau of Animal Industry Circular 125 and to the current regulations.

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human health. If a veterinarian is not available in some of the small villages the services of a local physician might be obtained. A physician without special veterinary training would not have the required knowledge of animal diseases and would not be able to recognize such diseases as readily as a veterinarian would. It is part of the veterinarian's special education not only to know about animal diseases, but to know, so far as science has determined, whether or not they are communicable to human beings, and to know when diseases and conditions found in animals are likely to be detrimental to the health of the human consumer of the meat.

Whenever it is necessary that laymen be employed to carry on inspection either by themselves or as assistants to veterinarians or physicians, they should have received special instruction in meat inspection under competent instructors. Where a layman is assigned to inspect in some remote place it could be arranged for him to send specimens of all doubtful cases to the chief inspector at some central point where they could receive proper examination, the carcass being held until a decision is reached.

Perhaps the most satisfactory plan of compensating the inspectors is for the State or the municipality to pay them annual salaries. No inspector should under any circumstances receive his pay directly from the slaughterers, for reasons that are obvious. The expense of inspection may be met by charging fees, but these fees should go into the State or municipal treasury, and not directly from the meat dealer or slaughterer to the inspector.

Where one man has to inspect at more than one place it will be necessary to arrange the times and days of slaughtering so that he can cover all places satisfactorily. A schedule could be arranged by which slaughtering would be done at one place on one day, at another place on another day, and so on; or slaughtering could be done at one place in the morning and at another in the afternoon. In Germany there are inspectors who cover several towns and who are known as ambulatory inspectors. It might also be permissible under some conditions and when absolutely necessary to permit slaughtering in the absence of the inspector, provided all carcasses and viscera are retained for his examination later. If the inspector can not be actually present at the time of slaughter the viscera should be held, under refrigeration if necessary, until he can pass on the animal.

Animals killed on the farm and brought to town for sale present a difficulty which may be met fairly well by requiring that they must have certain viscera attached and be brought to a certain point for inspection.

In the writer's opinion, when animals are found affected with any disease or condition which renders them unfit for food the producer should suffer the loss rather than the butcher, just as is the custom of the trade when fruit is found decayed or in bad condition or when

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wheat is moldy or spoiled. Even with the most expert ante-mortem inspection most of the cases of tuberculosis can not be detected, and usually the purchaser of a live animal is unable to determine until after slaughter whether or not it is diseased. The fairest way is for animals to be bought subject to their condition as disclosed at slaughter. When a carcass is condemned the loss should fall on the man who raised and sold the diseased animal. The presence of tuberculosis in cattle or hogs is usually due to the negligence of the farmer who raised them, and as long as he can sell them for full price there is no great incentive for him to get rid of the infection; but as soon as he begins to feel the financial loss he will find it to his advantage to eradicate the disease. On the other hand, the man who raises healthy stock should receive full price and should not have to share in the general depreciation of prices when buyers naturally take into consideration the fact that they will probably sustain some loss from disease.

It seems to me, too, that at least a portion of the loss on account of animals condemned in the meat inspection should be borne by the State or the municipality. The condemnations are made for the protection of the public health, and it is only reasonable that a part of the loss should be paid from the public treasury. The State of Pennsylvania has a law providing that when animals killed for food are found to be affected with tuberculosis and condemned the owner shall be reimbursed to an amount not exceeding 5 cents a pound for the dressed meat, or $25 for the entire carcass. Under this law the State live-stock sanitary board has fixed a scale of rates to be paid in such cases, ranging from 2 to 5 cents a pound dressed weight, according to the class and condition of the animal. Under this system the loss is divided between the State and the owner of the animal.

The use of injurious preservatives should be prohibited, as is done under Federal inspection. The Bureau of Animal Industry has found from examination of numerous samples that the use of preservatives which are prohibited by the Federal Government in food products is quite general among local dealers and others who are not subjected to inspection.

Meat that has been inspected and passed may be marked in the same way as in the Federal service, by means of a metal stamp and a specially prepared purple ink.

If a system of local inspection is to provide adequate protection to the health of the community it should cover absolutely all meat offered for public sale which has not been subjected to Federal or other competent inspection. All places of slaughter should be subject to inspection and regulation and permitted only by license. If any uninspected meat is allowed to be sold or if any slaughtering places are allowed to remain uninspected there will be danger to the health

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of the community. If an unscrupulous man wishes to dispose of diseased or suspicious-looking live stock he will take it to the place that is without inspection. If one man is allowed to maintain an uninspected slaughterhouse there will be a great temptation for him to buy stock that would not pass at the inspected places, and thus a single exception may be a source of great danger to the health of the people.

A MUNICIPAL SLAUGHTERHOUSE AT PARIS, TEX.

The city of Paris, Tex., in 1909 erected a municipal abattoir which is said to be the first such plant in the United States. The abattoir is located about 1½ miles from the city, and is a one-story wooden structure consisting of slaughtering department, chill room, cooler, tank room or reduction plant, power house, dressing room, toilet room, and storage room for fertilizer, the latter being located about 80 feet from the main building. The cost of this plant was about $10,000.

The daily capacity of the abattoir is about 30 beeves. The number of calves, hogs, and sheep that could be handled daily would probably be slightly in excess of that number. The slaughtering room is about 22 feet square with cement floor and painted wooden walls. There are three sewer drains discharging into a septic tank located about 50 feet from the building. All slaughtering operations are conducted in this room. The carcasses are hoisted by means of a hand windlass, which is a rather slow method.

The chill room is 10 by 18 feet, with cement floor, three walls plastered with cement and the other wall of wood. A temperature of 40° F. is maintained, and all carcasses are retained in this room for 12 hours before being removed to the cooler.

The cooler is 28 by 22 feet, with cement floor, cement plastered walls, and sewer connections. Refrigeration is supplied by a 10-ton ammonia plant.

The tank room or reduction plant is a small compartment adjoining the slaughtering department. It is equipped with one tank. The offal is handled by means of a windlass and rail. The rendered fat is sold to local laundries, and the tankage is disposed of as fertilizer. The sewage from this room is piped to the septic tank.

The inspection is performed by a veterinarian who receives a salary of $1,200 a year. The following fees are charged for killing: Cattle, $1.25 a head; hogs, sheep, and calves, 75 cents each. The patron receives the hide, liver, heart, caul, tail, and brain. Carcasses may be held in the cooler for 5 days and delivered to butcher shops or markets free of charge. For each additional day a charge of 10 cents is made.

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According to the mayor, Hon. E. H. McCuistion, the receipts from the operation of the abattoir for the first 6 months averaged $701 a month, while the average expenses were $562 a month, showing an average monthly profit of $139. The receipts from the plant are expected to pay not only the running expenses but the interest on the bonds which were issued to raise money for the construction of the plant, and to provide a sinking fund with which to meet the bonds when they mature.

Mayor McCuistion has the following to say with regard to the abattoir and the circumstances leading up to the undertaking:

Almost every person operating meat markets in the city maintained a separate slaughterhouse at which he slaughtered the animals sold at his market. The structures were rough plank; the location was usually in some thicket or in a swamp, and immediately surrounding each of the houses hogs were kept for the purpose of destroying the offal and waste from slaughtered animals. These pens being removed from the city the only water used was ordinarily from a pool on the premises or a shallow well. In either case it was about as filthy as it could be. During the summer season flies were about the premises in untold millions, and as soon as the animals were slaughtered they would rise up from the dump heaps and cover the carcasses. The odor naturally, of course, was terrific, and indeed the whole surroundings were such that it appeared to us that meat slaughtered under such conditions was not at all fit for food.

We tried for two years to induce the butchers to form a stock company and build an abattoir and reduction plant, operate it themselves, allowing the city to furnish an inspector only; but on account of jealousy and business rivalry this could not be done. The city then decided to undertake the work.

It is the purpose of the city to operate the plant without a profit. We have made charges which are supposed to cover the items of operation, insurance, interest and sinking fund for bonds, and allow 10 per cent for repairs. The total operating expense is about $400 per month, outside of fuel. The inspector who inspects at the abattoir is also the inspector of markets, grocery stores, confectioneries, dairy herds, and dairy products, and the fees for all these inspections are turned into the abattoir fund, and in that way aid in keeping not only the prices of slaughter and cold storage down to the minimum, but also aid in keeping all inspection fees down to the point where they are not a burden in any portion of our sanitary field.

Our plan is that all animals slaughtered for the local markets shall be brought to the municipal plant, and there undergo first a live inspection by a thoroughly competent inspector, after which they are slaughtered and then undergo the dead inspection. The rules governing the inspection are the same as observed by inspectors of the National Government in the packing plants of the country.

A PUBLIC SLAUGHTERHOUSE AT NASHVILLE, TENN.

In Nashville, Tenn., there is a public slaughterhouse owned by a corporation, the stock in which is held by a number of local meat dealers. This is a well-constructed brick building costing about $75,000. The plant has a daily capacity of 100 cattle, 300 hogs, and 100 sheep. The inspections are made by a veterinarian in the employ

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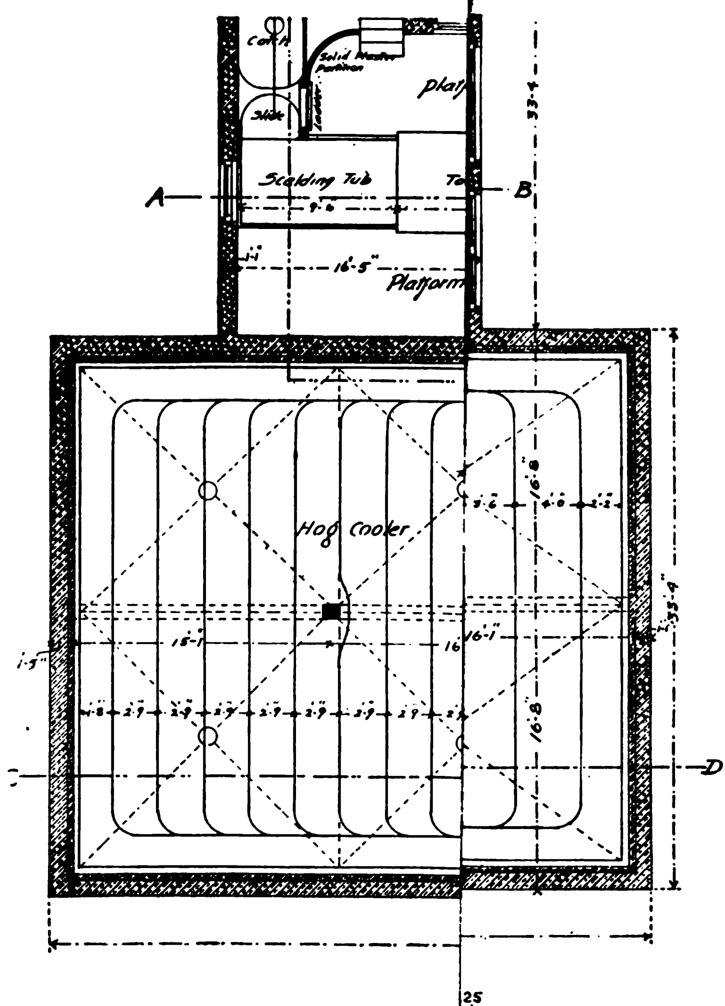

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of the city board of health. The charges for slaughtering are 75 cents a head for cattle, 25 cents for calves, and 15 cents for sheep and hogs. The association pays the owners of the animals for the hides, tallow, grease, and offal, these products being sold each month to the highest bidder. The city laws of Nashville require that all fresh meats sold in the city shall be from either city or Government inspected carcasses.

PLAN AND SPECIFICATIONS FOR A CENTRAL ABATTOIR.

I have had prepared by Mr. G. H. Parks, architect in the Bureau of Animal Industry, the accompanying plans, specifications, and estimates for a central abattoir of capacity sufficient for a small city of about 20,000 population. (See Figs. 17, 18, and 19.) Such a plant would cost from $12,500 up, according to capacity.

One building would comprise the slaughterhouse, containing the killing room, the cattle-dressing room, and the gut-handling space, divided as follows: Killing room, 14 feet by 15 feet 6 inches; cattle-dressing room and gut-handling space, 18 feet by 54 feet; all dimensions inside. Cost, frame construction, cement floors, walls cement lined, and ceiled roof, about $2,500.

A cooler building 32 by 48 by 20 feet inside, with concrete or stone foundation, wood walls and ceiling, composition roof, concrete floor, and cork insulated walls and floor, would cost about $3,000, and the machinery for the same, including refrigerating plant, would cost installed about $5,000.

The tank or rendering building should be so built that it will not be connected with the abattoir, and it can contain the steam plant. The rendering tank will require a floor space of about 5 by 10 feet. A building 16 by 24 feet, 14 feet high, will accommodate the steam plant and the rendering tank. A building of frame construction would cost about $500, and the steam plant and rendering tank can be installed for $2,500.

In this power house should be installed a dynamo to generate electricity for power to drive the motors on the cattle hoists, the motor for running the refrigerating machine located in the basement of the abattoir, and the electric lights and fans.

The slaughterhouse is constructed with two killing beds and has a maximum capacity of 150 cattle a day of 10 hours, but the cooler building has a daily capacity of only 10 cattle, 12 sheep, and 4 calves, on a basis of holding the carcasses 5 days. If hogs are to be killed another slaughter room 18 by 34 feet with a wing 10 by 15 feet, all inside dimensions, should be constructed, and additional cooler space provided, which would require an additional outlay of about $9,000 for a capacity of 22 hogs a day. This would bring the total cost of the plant up to $22,500. Concrete construction throughout would cost about 50 per cent more than frame construction.

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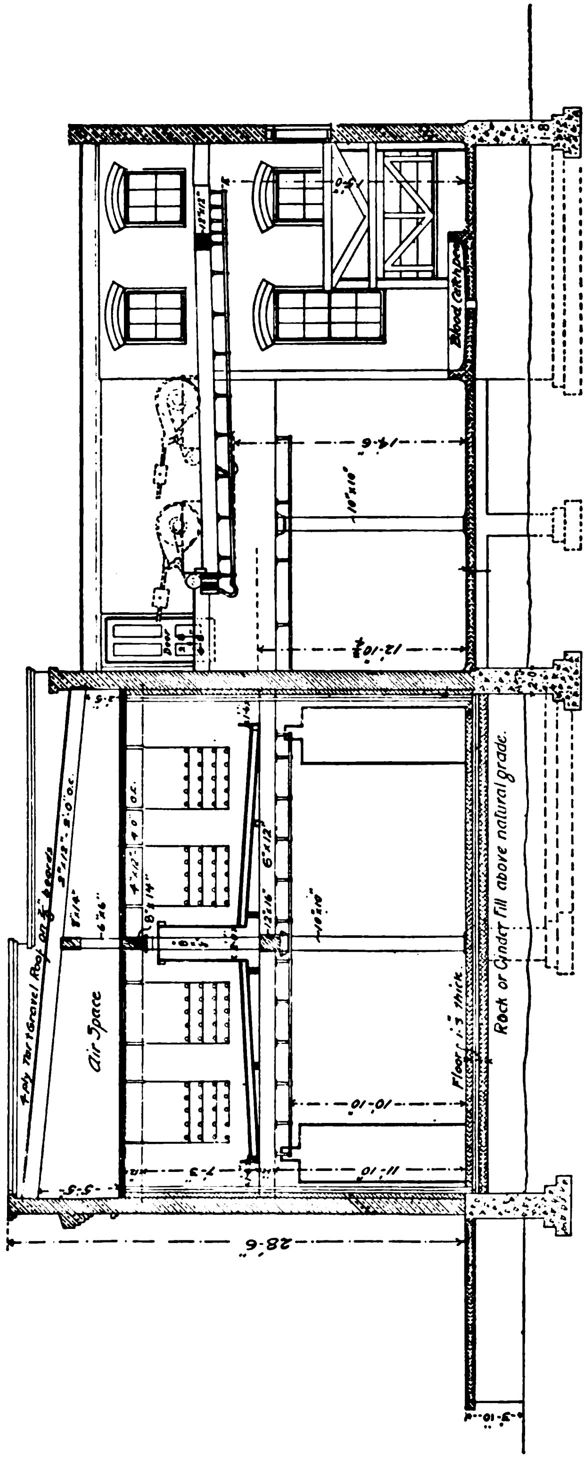

FIG. 18.—Cross section of municipal slaughterhouse. (Section on line E–F in fig. 17.)

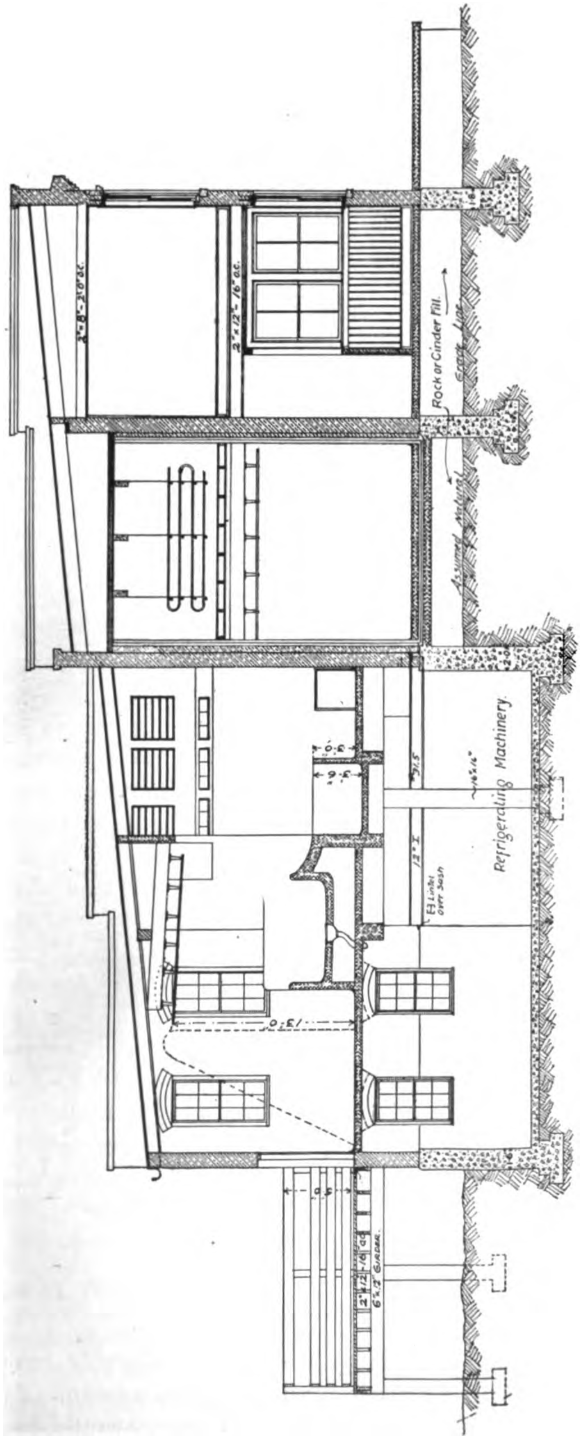

FIG. 19.—Cross section of municipal slaughterhouse. (Section on line G–H in fig. 17.)

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If the meat is kept in the cooler for a greater period than 5 days the capacity of the plant would have to be correspondingly increased.

A tank for the rendering of offal is an important feature, not only because it affords a safe method of disposing of this material, but

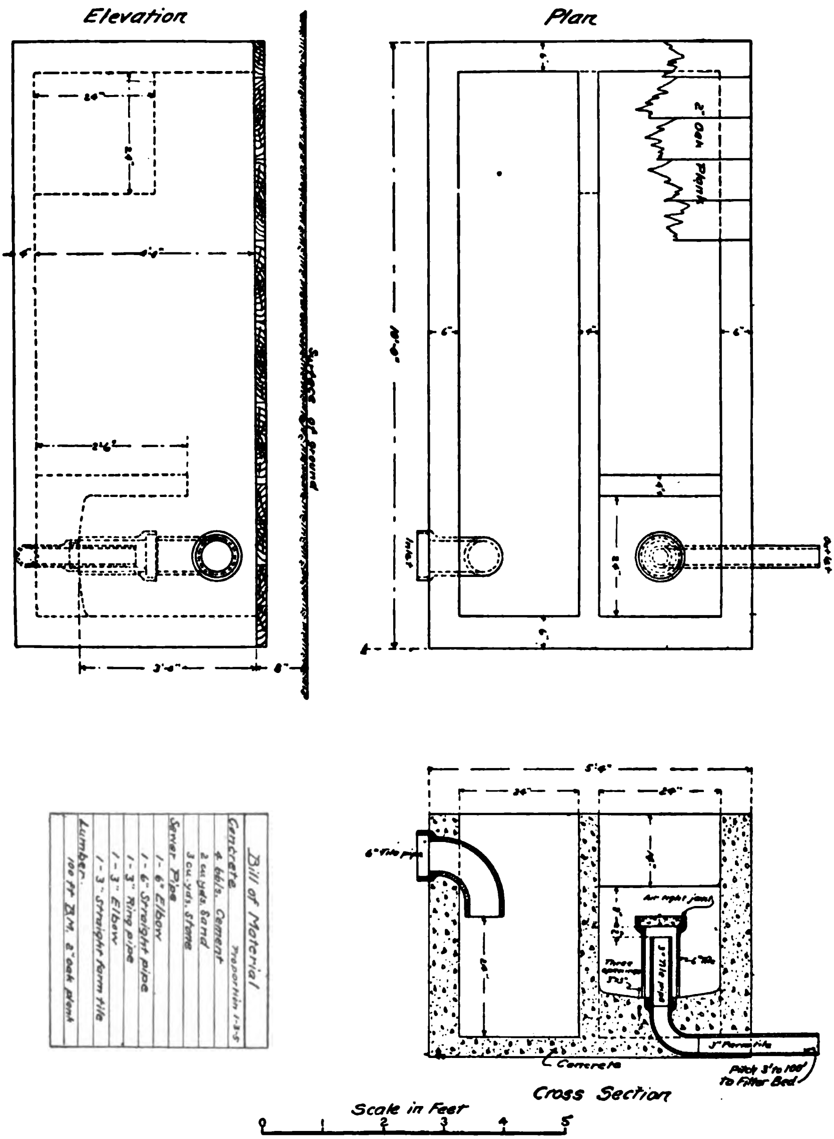

FIG. 20.—Plan for septic tank, 600 gallons capacity.

also because it can be made to yield a considerable revenue from what would otherwise be waste products. The amount of offal from the slaughter of 10 cattle, 12 sheep, and 4 calves would be about 950

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pounds green weight. If the killing were done once in 3 days the amount of offal would be about 2,850 pounds. When rendered into tallow and fertilizer this material would have a market value of about $24, which would amount to about $2,400 a year realized from the tankage. The cost of installing the rendering tank would be about $2,400. It is not likely that any extra labor would have to be employed to look after the tank. The cost of operation of the tank, including power, interest on investment, depreciation of the plant and fixed charges, such as insurance and office expenses, would be about $615 a year. The profit from disposing of the offal in this way is therefore estimated at $1,785 a year, which would make the installation of a rendering tank an exceedingly profitable investment.

If a rendering tank is not installed the offal should be put into closed metal containers and removed from the premises after each day's killing.

When a municipal sewer is provided, the sewage, except from the toilet, should be run into a concrete catch basin and from the basin to the city sewer. Sewage from the toilet should go directly to the city sewer without first passing through the catch basin. The catch basin is constructed as a long, narrow trough having partitions or weirs at right angles to its sides. The weirs retain most of the grease that is contained in the sewage. The grease can be skimmed off and put into the rendering tank. The catch basin should be located outside the abattoir and in such position that the odors will not permeate the abattoir, and should be provided with a tight cover.

When no municipal sewer is available the sewage from the catch basin and from the toilet should be run to a septic tank. The septic tank is made in a similar manner to the catch basin, but is so arranged that it contains two or three chambers into which the light and air are not allowed to enter. In these dark chambers the solid matter is decomposed and converted into liquid; the liquid is then conveyed over a bed of sand or carried away through agricultural tile and distributed. The chambers or compartments should be large enough to hold at least two days' supply of the sewage. If the sewage is to be carried over a filter or sand bed, the second compartment should be so contrived that the sewage will be syphoned intermittently. Sewer pipe to the septic tank should have a fall of 1 foot in 40 feet and be below the frost line. The tank should be 5 feet below the inlet. A plan for a septic tank is shown in figure 20.

LOCAL INSPECTION WITHOUT CENTRAL ABATTOIR.

In communities where a public or central abattoir is impracticable the inspection authorities should exercise close supervision over the private slaughterhouses and enforce sanitation so far as possible under the circumstances.

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Certain features necessary in the production of wholesome meat are usually lacking at local abattoirs, as, for example, sewerage and a good supply of pure water, both hot and cold.

Perhaps the most difficult problem in a small slaughterhouse is the disposal of the offal. This material should not be allowed to be fed to hogs, and should be disposed of in some way so that hogs, dogs, and other animals can not have access to it. When practicable a rendering tank should be provided for the offal and for such meat or product as may be condemned, and there should be facilities for applying steam to this tank. This equipment, however, would be too expensive for many small places, and some other method of disposing of offal must be found.

When a rendering tank is not practicable it would be well to have a septic tank, as already described. If this can not be done, the contents of the stomach and intestines might be removed and hauled away and spread on the ground, where they would have some fertilizing value. The other offal in the form of tissue, as well as heads, feet, etc., might be rendered in a kettle, the grease utilized, the bones collected at intervals and sold if practicable, and the residue used as fertilizer. It is much better to render such material than to throw it on the ground and allow it to decompose.

In a local system of inspection where no tanking facilities are provided there should be some simple way of treating condemned meat so it can not be sold for food. Perhaps the best and simplest way is to put kerosene on it.

BUREAU WILL FURNISH PLANS AND INFORMATION.

In carrying out local inspection the principles and rules laid down in the Federal regulations should be followed so far as possible. The Bureau of Animal Industry will be glad to furnish copies of its regulations and any other information or advice in its power to State or municipal officers who are interested in establishing local inspection. The bureau will also be glad to furnish plans and specifications and such other information as it can give with regard to the designing, construction, equipment, and operation of public abattoirs.

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PROGRESS AND PROSPECTS OF TICK ERADICATION.

By Cooper Curtice, D. V. S., M. D.,
Veterinary Inspector, Inspection Division.

The southern portion of the United States has long been afflicted by the presence of the cattle tick *Margaropus annulatus*. These ticks spread the infection of the disease known as Texas fever of cattle and often infest cattle so numerously as to stunt their growth and seriously affect their condition. Their presence necessitates a quarantine under which cattle from the infected regions may be shipped to other parts of the country only under certain restrictions and for immediate slaughter. The ticks also largely prevent the introduction and breeding of fine stock. The damage and losses caused by these parasites are enormous, being estimated at from $40,000,000 to $200,000,000 a year.

Systematic cooperative work by the Federal Government and the affected States for the eradication of these ticks has now been in progress nearly five years, and it is opportune to pause and look over the field to ascertain what has been accomplished, what obstacles have been encountered, and what may be done to assist in the further prosecution of the work.

THE BEGINNING OF TICK ERADICATION.

At a meeting of the commissioners of agriculture of the cotton-growing States held in Raleigh, N. C., in 1899, the Hon. S. L. Patterson, commissioner of agriculture of North Carolina, directed the writer to present the aim of that department in improving the cattle industry by tick eradication. From this beginning until 1906 12 counties in that State had been released from quarantine and 15 mountain counties had been permanently protected from the hitherto perennial threat of a Federal cattle quarantine. The commissioners' association and various allied organizations, influenced by the eradication work of North Carolina and the results obtained by Federal, State, and other investigators, together with the growing necessity of ameliorating the effects of the boll-weevil invasion, prevailed upon the United States Congress to make an appropriation in 1906 to empower the United States Secretary of Agriculture to inaugurate a plan of cooperation with the authorities of Southern States in the eradication of the cattle tick. The Federal appropriation for the fiscal year ended June 30, 1907, was $82,500, and for 1908, $150,000. Annually since then $250,000, a sum sufficient to meet the advances of

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those States interested in the work, has been appropriated. It is probable that succeeding Congresses will continue to meet the demand for future cooperation in the degree that States show real interest and actively engage in tick eradication.

In 1906 there were 15 States more or less infested with cattle ticks. These contained 929 counties that were quarantined to prevent the cattle from carrying the ticks into uninfected territory. While preparing to cooperate with the Southern States, the Chief of the Bureau of Animal Industry, to whom the Federal work had been assigned, ascertained that but 7 States had laws which would enable the bureau to cooperate with them. Work was begun is these, viz: Virginia, North Carolina, Georgia, Kentucky, Tennessee, Oklahoma, and California. Since then other States have enacted laws and undertaken cooperation, notably South Carolina, Alabama, Mississippi, and Arkansas.

RESULTS OF FIVE YEARS' WORK.

The results of the cooperative work for the eradication of ticks from July 1, 1906, to April 1, 1911, are as follows:

In Virginia there still remain infected 6 counties and parts of 2 counties, while 24 have been released from quarantine.

In North Carolina 30 counties have been cleaned, out of 72 infected in 1906. There are 8 of its 42 infected counties now cooperating. Twelve infected and quarantined counties were released on account of being disinfected of ticks by State action between 1900 and 1906. Ticks have been cleaned from 42 counties in North Carolina.

In South Carolina 4 counties out of 42 infected in 1906 have been released. There are 8 others nearly clean.

In Georgia 3 out of 144 counties infected in 1906 have been released. Three mountain counties had previously been disinfected.

Kentucky has been completed. In 1906 there were 2 infected counties and small areas in 2 contiguous counties.

In Tennessee 26 counties and parts of 8 counties have been released, and 7 counties and parts of 5 counties remain in quarantine. Six counties are now cooperating.

Alabama has cooperated in 7 out of the 67 infected counties.

In Mississippi 3 counties and four-fifths of the area of 2 others have been released, out of 78 infected in 1908. There are 17 counties now cooperating.

In Arkansas 10 out of 75 counties have been released since 1907. Work is going on in 9 others.

Louisiana has cooperated in 2 out of its 60 counties. These 2 are nearly clean.

In Oklahoma 7 counties and parts of several others have been released. There were 59 originally infected.

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In Texas 7 whole counties and parts of 5 other counties out of 190 infected counties have been released.

California has but 3½ of the 15 originally infected counties remaining, and these are nearly completed.

Missouri has 4 counties or parts of counties under quarantine.

Florida is doing no work in tick eradication.

Summary: There have been freed of ticks and released from quarantine 127 counties and parts of 20 counties out of 929 originally infected; 90 are in varying degrees of disinfection. Over one-seventh of the counties have been cleaned, and over one-fifth of all the originally infected counties have been worked in. About one-tenth of the counties now infected are being worked in and are partially clean.

Counties have been adopted as the unit of area in the statement of results just presented, rather than square miles or numbers of head of cattle, for it is with the county authorities and areas that both State and Federal authorities are compelled to deal. The areas of counties vary widely in different States and in the same State, yet the unit is a convenient one and gives a better idea of progress than any estimate of cattle or square miles released. When cost is to be considered, both of the latter must also be taken into account to obtain a comprehensive view of the eradication.

The progress of tick eradication in various States since 1906, shown both by counties and by spuare miles, is given in the following table and also by the accompanying map (fig. 21). A comparison of the completed area (139,821 square miles) with the original area (741,515 square miles) shows that one-fifth of the mileage area has been completed. The vast size of the desert counties in southern California now released accounts for much of the difference between the one-seventh of the counties and one-fifth of all area as shown by square miles.

Progress of tick eradication.

State.	Counties infected Aug. 1, 1906.	Counties infected Apr. 1, 1911.		Counties released up to Apr. 1, 1911.		Counties in which eradication is in progress.	Square miles released up to Apr. 1, 1911.	Square miles infected Apr. 1, 1911.
		Whole.	Parts.	Whole.	Parts.			
Alabama	67	67	0	0	0	7	0	51,540
Arkansas	75	65	0	10	0	9	7,220	45,825
California	15	3	1	11	1	3	67,977	11,947
Florida	47	47	0	0	0	0	0	54,240
Georgia	144	141	0	3	0	6	815	57,328
Kentucky	2	0	0	2	2	0	841	0
Louisiana	60	60	0	0	0	2	0	45,420
Mississippi	78	73	2	3	2	17	2,032	44,308
Missouri	4	4	0	0	0	4	0	1,595
North Carolina	72	42	0	30	0	8	13,993	23,372
Oklahoma	59	52	0	.7	0	6	7,890	40,000
South Carolina	42	38	0	4	0	8	2,673	27,497
Tennessee	42	8	4	26	8	6	11,989	17,210
Texas	190	178	5	7	5	11	13,311	178,574
Virginia	32	6	2	24	2	3	11,080	2,838
Total	929	784	14	127	20	90	139,821	601,694

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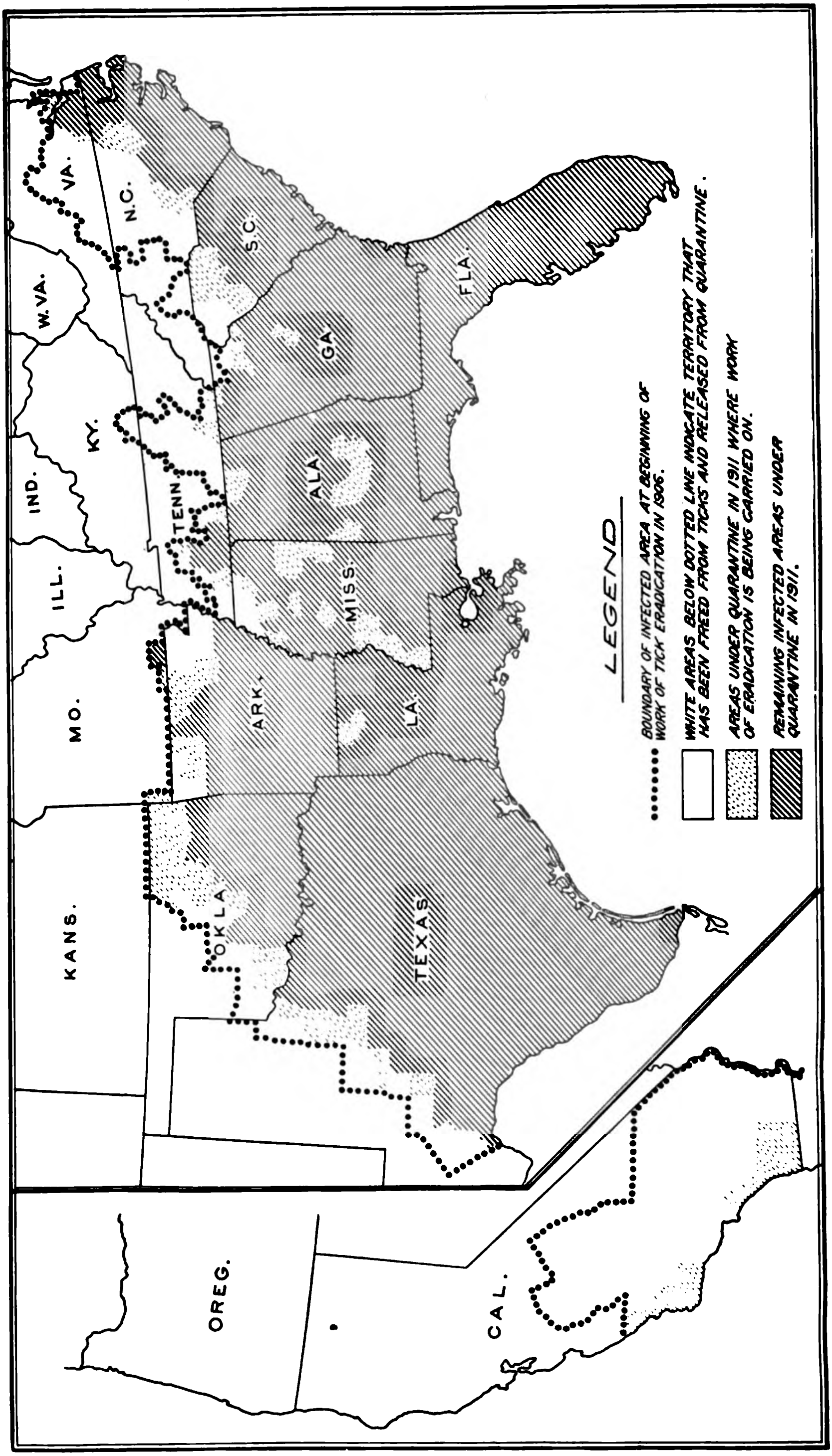

FIG. 21.—Map showing progress in eradicating cattle ticks.

SOME OBSTACLES TO PROGRESS.

Ignorance has been a great obstacle at all stages. While leaders in communities are informed concerning the benefits of eradicating the ticks, they are in the minority, and educational processes must still go on. The opposition is fortified with certain attendant drawbacks which are sometimes pointed out, and by a vast amount of misinformation which must be corrected. At the preliminary meeting of those interested in tick eradication held in Richmond, Va., in 1905, Dr. Tait Butler, then State veterinarian of North Carolina, took occasion to say to doubting members: "But it is being done; it has been done." If the doctors disagreed then, how much could have been expected? And how much can now be expected of him who lives isolated and reads not, or, reading, doubts? But it is upon this man—the farmer who has seen ticks all his life and knows no facts to point out their potency for harm—that States and counties are dependent for hastening the work.

Decidedly the hardest fifth of the work has been done, for where few farmers were well informed concerning tick eradication in 1906, thousands scattered throughout the tick belt now know that it is successful and are awaiting the day when their counties may begin the work. They are not yet in the majority, but their numbers receive yearly accessions. Where no county sought cooperation in 1906, many are waiting now. Where no county made any considerable appropriation in 1906, many now employ as many agents as the State furnishes, or more. Where the Bureau of Animal Industry furnished supervision and agents then, it furnishes but the former now. Where no money had been appropriated prior to 1906, the Federal Government now devotes $250,000 annually, and States and counties more than $150,000 more. These appropriations will likely increase rather than decrease, on account of awakened demand.

Rapid progress in tick eradication is dependent in large part upon the thorough control exercised over the cattle during summer, fall, winter, and spring, that they may not scatter ticks which may eventually infect other cattle or reinfect themselves through the seed ticks. The custom of turning cattle out to range through the unfenced swamps and roadsides prevents any tick eradication in many counties. The custom almost universally followed throughout the South of turning out cattle after the crops are gathered and letting them roam at large until the spring crops begin to grow has prevented success in many counties where tick eradication has been undertaken. Counties where this is permitted are known as "free-range" counties, while those having laws against cattle running at large are known as "stock-law" counties. When stock-law counties have been cleaned further effective work must wait until "stock law"

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is adopted in the free-range counties. Cleaned cattle will always be more or less exposed to the ticks in the infected free-range regions.

Three-sevenths of the counties still infested, the majority of these being in the States bordering on and east of the Mississippi River, are free range. While counties have been successful in eradicating ticks under free-range conditions where cattle were cared for and kept under sufficient control summer and winter, there has been no success even in stock-law counties where the cattle have been turned out to range during the winter. Canebrakes, fodder, dried grasses, and spring grasses may make cheap forage, but they have certainly made cheap cattle and have been demoralizing to the southern cattle and farming industry by preventing forage crops, winter-cover crops, winter grains, and good breeding, and by encouraging thriftless management of cattle and stock. During the past year there have been stock-law counties cooperating in tick eradication, a majority of whose citizens have desired to stop work when it was pointed out that an agreement had been made with the county authorities that stock law should be observed all the year. The idea was not that tick eradication was harmful, but that winter pasturage was worth more than clean cattle and a market. The overcoming of this—the greatest obstacle to tick eradication, if not also to diversification of southern field products, especially hay and grain—needs the cooperation of every agricultural educational agency in the South.

Another class of obstacles lies in the methods of eradicating ticks. The surest methods, those depending on pasture rotation or feed-lot systems, fail because they are not used. Rotation is but exceptionally practiced. There are few fences other than the single pasture fence in the stock-law counties and the crop fence in the free range. These methods are practically and theoretically the best, but only those people conversant with the long educational campaign designed to bring about crop rotation and diversification of products can realize why they are not adopted. It is the free winter pasturage which costs the southern farmer so much.

There are left the tickicides, including oils, crude petroleum, and arsenical solution. They are applied by hand swabbing, by spraying, or in dipping vats. The methods are successful in the order named, the last being the best. In every county there are a number of doubting people who grudgingly make a show of disinfecting cattle. There are others who will not disinfect unless repeatedly urged. Such as these are careless about the material used and about the application. They fail of success for a long time. There is still another class who really try to do their best. They may be misguided in the kind of remedy used; they may purchase what agents direct, but the material furnished may prove wrong; either it is too weak in the strength advised, or if oil it will not emulsify in the hard waters

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of the county. Too often the work is put off until large ticks have developed. The result is bad; no good is accomplished, and the season passes. The end is retarded.

More recently, however, arsenic solution has been willingly adopted by ever-growing numbers. It is sometimes applied by hand, but oftener by spray pumps or in the vat. In one county over 125 vats have been made; in other counties, from 25 upward. In some cases the counties pay for the cement and disinfectant used, and the people of the communities furnish gravel, sand, lumber, and labor. The farmers drive their cattle to these vats at stated times twice a month and dip them, the process often being supervised by the agent. The cattle being thoroughly immersed, all ticks are wet in the solution. The errors of greasing methods by hand and spray pumps are avoided. The arsenic solution, being cheaper and less injurious to the cattle, is preferred to the oil. The public vat with arsenic solution is succeeding easily where other methods have failed. Each State should adopt and use it wherever possible.

If States could devise a method by which disinfection would be compulsory, there might be no need of farm quarantine during the first year's work. If cattle were driven to the vat regularly eight or ten times, there would be little need for further dippings unless some animal had been accidentally left behind or overlooked. The quarantine of the few farms in the second year would not be so burdensome as the quarantine of the many which are now quarantined the first year. When the cost of constructing vats and of the disinfectants is paid by the county or State the time required for tick eradication is shortened and the cost of the work is lessened, thus making this by far the most economical method. If tickicides are to be employed, the community vat is the only cheap and efficient method. All others temporize.

Intercounty quarantines are unavoidable to a certain extent. Their restrictions can be greatly lessened by adopting large areas of disinfection. A prolonged maintenance of quarantine between clean and infected areas not only instructs the residents of the former in maintaining it but the latter in the necessity of tick eradication if they desire unrestricted movement of cattle. Such education is imperative before quarantines are lifted from clean areas. The efforts of the State should be directed toward engaging in cooperation as large blocks of counties as possible.

In the first year's work in many counties it has been difficult to get convictions of violators. They choose jury trials, and disagreements are the rule. Trials before justices of the peace now often succeed. It seems quite difficult for the average juryman on these trials to base a decision on the evidence as presented. He is either for or against the "tick law."

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The personnel of the officers engaged in tick eradication comprises United States veterinary inspectors, used as supervising inspectors, and State and county agents, who do the main work of inspection. The efficiency of each depends upon his capability, including tact and training. In 1906 all were new. Since then there have been continued changes. Exigencies of the service have required the shifting of Federal officers; completion of the work in counties has compelled the discontinuance of local agents. Even States have not built up a force of efficient workers because the pay allowed has been insufficient to maintain men away from home. The Federal force is continually improving because of the retention of men showing tact and adaptability and because of their acquired experience. The States should as time passes unite the best of the State and county agents into an active body for future work. The new agent takes some time to learn his duties and, having no previous experience, his first year is generally lost. Counties should call upon the State for a list of trained men and employ them as local agents. Much time is thereby saved. It is questionable, however, whether there should be any local agents. State agents should replace them, and a certain proportion should be paid from county funds. As the force is improved many of the obstacles now met in the field work will be removed.

The obstacles in the way of tick eradication may be summarized as follows:

1. Ignorance, which may be and is being removed through the instruction of agricultural workers and by the publication of information on tick eradication.
2. Failure of disinfectants through ignorance in using a faulty quality of material and carelessness in application. This condition is being improved by the use of arsenic solution in vats.
3. Failure to control cattle on account of free range, and lack of winter forage, fodder, and grain crops. This is the most serious obstacle and can be overcome only by persistent effort in demonstrating a better way and by enforcement of an all-the-year-round stock law.
4. Friction created by working in too small areas. Working in larger areas would relieve many local quarantine restrictions.
5. Failure of juries to convict violators on the evidence.
6. Untrained agents, due to frequent changes. The retention of the best State and county agents is advocated. State appropriations should be made with reference to finishing the work at an early date by proceeding at a regular annual rate.

SOME REASONS FOR TICK ERADICATION.

The effect of the invasion of a new territory by the cotton boll weevil is to turn the attention of the planters to producing diversified crops. Because they can no longer borrow money on the cotton

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crop to buy supplies they turn to raising crops to feed their animals and families; then they increase their farm animals to consume the abundant forage they may raise. Thus cattle become a money crop and the planters are ready to pay more attention to them. Since successful cattle feeding and marketing depend upon the removal of the ticks, the work of tick eradication is taken up.

Money has been advanced to the planters in the South solely upon the future cotton crop. There has been no other crop to borrow on. Because everything had been bought at a high price, little money remained in the country when settling day came. The boll weevil thus has its effect upon the fertilizer bill. Commercial fertilizer can not be obtained on a crop so uncertain as cotton in the first few years of boll-weevil invasion. But fertility of the soil is one of the prime requisites for raising cotton and forcing its growth. Thus it happens that the raising of cattle is advised by agriculturists to produce the much-needed manure at the least cost. The cattle consume home-raised forage and restore nearly all in an available form to the soil. Fields used for pasturing or feeding cattle in the past have shown the effect of the manuring in the increased growth of cotton for 25 years after the cattle were removed.

The planters of southwestern Mississippi took up tick eradication because the boll weevil forced them to do this. This region has been practically the first to take it up without urging, and judging from this event it may be concluded that tick eradication will follow the advance of the boll weevil from westward to the east without further urging.

It is recognized that ticks are the principal if not the only cause of depression of the cattle industry in the South, as the necessary feed may be easily raised there when cattle are considered to be worth the trouble. Tick eradication will thus build up another southern industry and help to maintain cotton production through the manure, a by-product of cattle feeding. Further, the cottonseed meal now sent elsewhere for feeding cattle and making commercial fertilizer will be retained for the same purpose at home, and the loss now incurred by its shipment will thus be stopped.

When these facts are thoroughly recognized, and the southern planter is brought face to face with the boll weevil, tick eradication will receive the attention it merits.

PROSPECTS FOR THE FUTURE.

The fact that one-fifth of the infested area has been cleaned in the past five years does not afford grounds for estimating future progress. It is not reasonable to conclude that because the area cleaned was situated along the northern boundary it was easier to clean, and

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therefore that the remainder will require a proportionately longer time, or that because four-sevenths of the remaining counties are free-range territory this condition will indefinitely prolong the work. On the one hand, better methods will hasten work, and, on the other, stock law may be adopted any year. It is true that tick eradication as now conducted waits on stock-law sentiment to prevail. Perhaps the demonstrated success of the work in one-seventh of the counties will prove an object lesson that will go far toward overcoming obstacles in the remaining area. There is hope that tick eradication, which has so far gone falteringly ahead, will soon advance with firmer tread toward its goal.

The centers of greatest activity will be for a year or two in the States of Oklahoma, Arkansas, and Mississippi, if the present situation is indicative of immediate future operations. The work in the States of Virginia, North Carolina, Tennessee, and California is either drawing to a close or coming to a standstill while waiting for backward counties to take up the work. Slow progress is indicated in South Carolina, Georgia, Alabama, Louisiana, and Texas; none in Florida. Unless more decisive action is taken in the free-range regions, the work in all States will halt at the free-range boundary.

If States should decide to take up an average of five stock-law counties yearly, the free-range limit would be reached as follows: North Carolina, 2 years; South Carolina, 6; Mississippi, 6; Alabama, 8; Oklahoma, 10; Georgia, 21; Texas, 35.

If it is assumed that free-range counties will come under stock law at the same rate, the States will be completed as follows: Virginia, 2 years; Tennessee, 3; South Carolina, 6; North Carolina, 9; Oklahoma, 10; Arkansas, 12; Louisiana, 12; Alabama, 13; Mississippi, 15; Florida, 10, plus the time it takes to start; Georgia, 29; Texas, 37. Any differences in the annual rate will hasten or delay the final date.

These figures have little value excepting as they convey an idea of the duration of the task and its completion under certain plans of action. Their study should stimulate authorities to plan for eradication to proceed at a certain definite rate. When it is considered that as many counties can work together as desire, it seems futile to delay the end beyond a reasonable time; for example, 10 years. It is, indeed, more profitable to take up areas containing 10 or more counties annually. At such rate the stock-law counties of all States except Georgia and Texas would be completed in 5 years. Even the State of Georgia need not be far behind, because 20 counties should be taken on account of the small size of each, and thus only half the time would be consumed. The infected area of Texas is about three times as large as that of any other State; therefore Texas should do three times as much work, or even more, for she has a greater cattle industry and more at stake. It is not impossible for the ma-

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jority of Texas counties to be completed within 10 years. If this is done, however, the work must be prosecuted on a much larger scale than at present.

Most States have not as a whole desired tick eradication in the past. The comparatively meager appropriations have been made on account of only a few counties desiring to work. Just as the boll weevil stimulated Congress to make the first appropriation, and just as it caused Mississippi to take sudden interest recently, just so will it arouse enthusiasm in Arkansas, Alabama, Georgia, and Florida, as it reaches those States later on.

The cost of tick eradication to the Federal Government up to date has been less than $1,000,000. Excluding over 40,000 square miles of semiarid lands released in California leaves 100,000 square miles disinfected at a cost to the Federal Government of less than $10 per square mile. The cost to the States and counties has so far been much less, and there seems to be no prospect of its becoming more than that. The cost to the farmer is so quickly repaid by the well-being and improvement in cattle that all complaint of increase in taxes is quieted as eradication proceeds.

As one-seventh of the tick-infested territory has thus been cleaned at a cost to the Government of less than $1,000,000, the other six-sevenths would, at the same rate, require about $6,000,000. The estimated cost to any State may be attained by multiplying its infected mileage by $10. It is probable that this cost will be maintained whether a State requires 5 or 20 years to complete disinfection.

Elsewhere, it has been stated that the minimum loss to the infected States was over $40,000,000 annually. It is apparent, then, that disinfection of one-seventh of the counties is saving the country about $5,000,000 annually, and that the tick-eradication service has already conserved to the country values far greater than the cost of the work. As time proceeds these conserved values will increase and accumulate, adding to the prosperity, not only of the South, but of the whole country.

The benefits of tick eradication are no longer a dream. In an area larger than two ordinary States formerly tick infested and pest ridden the cattle are now free of ticks and thriving as never before. They may be marketed without quarantine restrictions, and at better prices than cattle from the tick-infested area. Farmers are introducing improved stock and increasing their herds. Better arrangements are made for providing winter feed and otherwise caring for them. A new money crop has arisen from what was a neglected industry. And more than all this, the increased fertility of the soil brought about by a diversification, including forage crops, and the use of stable manures, has enabled the cotton farmer who has eradicated cattle ticks to prepare for the invasion of the boll weevil in such a manner as to feel its effects least.

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THE USE OF ARSENICAL DIPS IN TICK ERADICATION.

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AND
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INTRODUCTION.

It is now a well-known fact that the Texas-fever tick may be eradicated from cattle and pastures by following certain courses of procedure in which the cattle are moved from time to time from one pasture to another; in other words, eradication may be accomplished by so-called "rotation methods" without the necessity of treating the cattle with tick-killing substances. In many instances, however, it is impracticable, uneconomical, or on some other account undesirable to depend upon the automatic eradication which ultimately takes place when proper rotation methods are followed, in which case it becomes necessary either to use them in connection with other methods or to resort to other methods alone. In such cases the dipping or spraying of cattle with a substance destructive to ticks provides a means of hastening eradication and of rendering eradication possible in the presence of conditions under which unmodified rotation methods would be practically out of the question.

Ever since the fact that the tick is the agent of transmission of Texas fever was established, investigations have been carried on under the auspices of the Bureau of Animal Industry, State experiment stations, and other institutions for the purpose of discovering some substance which when applied externally to the bodies of tick-infested cattle would free them from ticks without injury to the animals themselves. Very early in the history of these investigations it was found that ticks were highly resistant to treatment, and it has been determined that several remedies which give good results in the case of such external parasites as mange mites and lice are of little or no use in the case of ticks. Some substances appeared to have absolutely no effect, and others when applied at a sufficient strength to destroy the ticks were so severe in their effects upon the cattle that they could not be used in practice. For example, lime-and-sulphur, tobacco, and coal-tar dips, which are very satisfactory remedies against certain other external parasites of cattle, have been found to have no practical value in the destruction of ticks. Oil dips have proved more successful, and for several years crude petroleum, provided it conformed to certain requirements as to its physical and

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chemical characteristics, has been recognized by the live-stock sanitary authorities of the Federal Government and of various States as an efficacious remedy against cattle ticks. Although the efficacy of crude petroleum is generally admitted, there are a number of more or less serious objections to it which have largely interfered with its usefulness. Among these objections may be mentioned the facts that in practice crude petroleum of proper composition is difficult to procure, is rather expensive, bulky, liable to loss by leakage, is frequently very severe in its effects upon cattle, and produces a greasy condition of the hair and skin, which is highly undesirable in the case of dairy cattle.

About five years ago the Bureau of Animal Industry began investigating arsenical solutions with reference to their utility for dipping cattle to free them from ticks. At that time arsenical dips as remedies against ticks had been considerably used in South Africa, and to some extent in Australia and South America, but practically not at all in the United States. In 1906, following the publication of two articles by Dr. N. S. Mayo,[1] at that time chief veterinarian of Cuba, in which an arsenical solution was highly recommended as both efficacious against ticks and noninjurious to cattle, a number of trials of arsenical solutions were made in Texas, at first under cooperation between the Bureau of Animal Industry and the live-stock sanitary commission of Texas, and later by the Bureau of Animal Industry working alone. The composition and method of preparing the arsenical solution, as described by Mayo in the first reference given, are as follows:

White arsenic ---------------- pounds--	1½
Sodium carbonate, crystals ---------------- do----	4½
Yellow soap ---------------- do----	4½
Pine tar ---------------- quart--	1
Water ---------------- gallons--	100

The arsenic is to be dissolved in 5 or more gallons of water by boiling for one-half hour; when dissolved add it to 20 gallons of water. Shave the soap, mix with the soda, and dissolve in 5 gallons of water. When dissolved, add the tar in a fine stream and stir until the tar is in solution, then mix with the arsenical solution and add sufficient water to make 100 gallons.

In the second article referred to, appearing about a month later, Dr. Mayo gave a somewhat different formula but essentially the same method for preparing the arsenical dip, as follows:

Arsenious acid ---------------- pounds--	8
Soda carbonate, crystals ---------------- do----	24
Yellow soap ---------------- do----	24
Pine tar ---------------- gallons--	1
Water ---------------- do----	500

[1] Breeder's Gazette, vol. 49, No. 11, p. 564, and American Veterinary Review, vol. 30, No. 2, p. 243.

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Dissolve the arsenic in 20 gallons or more of water by boiling for 30 to 40 minutes. When dissolved, add to 100 gallons of water. Dissolve the soap and soda in 20 gallons of boiling water, first shaving the soap, and while boiling add the pine tar in a thin stream and stir until it is dissolved. Mix this with the arsenical solution and add sufficient water to make 500 gallons.

In the course of the first year's trials of the dip in Texas Dr. Mayo's formula was slightly modified by the omission of the soap, which did not seem to add to the efficacy of the dip. The formula and method of preparation which were usually employed are as follows:

White arsenic	pounds	8
Sodium carbonate	do	24
Pine tar	gallons	1
Water sufficient to make	do	500

The arsenic and sodium carbonate were dissolved by boiling in 25 or 30 gallons of water, after which the fire was drawn and the solution allowed to cool somewhat. The tar was then added, and finally the mixture was added to sufficient water to make 500 gallons of dip.

During 1906 about 12,000 head of cattle were treated in Texas with the arsenical dip under the supervision of inspectors or agents of the Bureau of Animal Industry with results which in some respects were highly encouraging. Though it appeared questionable from the reports of these dippings whether the dip was absolutely efficacious, there seemed to be no question as to its highly destructive action on ticks and, as compared with crude petroleum, its slight injurious effects upon cattle. In fact, the apparent merits of the dip were such that its use was enthusiastically adopted by cattle owners in Texas and has been continued up to the present time, the range of popularity of the dip increasing from year to year.

In consequence of the promising results secured in the first trials of the arsenical solution the Bureau of Animal Industry has carried out a number of investigations and experiments in order to obtain definite data relative to the efficacy of arsenical solutions as remedies against ticks.

A detailed report of these investigations and experiments has been written for publication in separate form,[1] and accordingly only a general discussion of results will be given in the present article.

DISCUSSION OF RESULTS OF EXPERIMENTS.

COMPOSITION OF THE DIPS USED.

In most of the experiments the arsenical solution used was compounded in accordance with the modification of Dr. Mayo's formula given above, the amounts of arsenic varying from 8 to 12 pounds, and of sal soda from 24 to 45 pounds, for each 500 gallons of dip, in dif-

[1] Bureau of Animal Industry Bulletin 144.

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ferent instances. When pine tar was used it was added in the proportion of 1 gallon to each 500 gallons of dip. In some of the experiments arsenical dips of somewhat different composition were used. The amount of arsenic in solution in the various dips, expressed in its equivalent of arsenic trioxid, varied from 0.16 to 0.495 per cent.

In the Mayo dip and its modifications the arsenic is present in the form of a sodium salt known as sodium arsenite[1] which results from the chemical reaction which takes place between the arsenic (arsenic trioxid) and the sal soda (sodium carbonate) when these substances are boiled together.

The proportionate amount of sal soda used in the arsenic, sal soda, and pine tar mixture is more than is necessary to transform the arsenic into sodium arsenite. It has not been determined whether a dip containing an excess of soda is more efficacious than one in which just enough soda has been used to complete the reaction with the arsenic. In view of the fact, however, that the cuticle of ticks is softened and may be dissolved by alkaline solutions, it is possible that the efficacy of the dip may depend in part upon the weak alkalinity given to it by the excess of soda used in its preparation. The function of the pine tar in the dip is indefinitely known. Whether it actually renders the dip more efficacious is uncertain. It does, however, give body to the dip, and also serves the useful purpose of rendering the appearance and odor of the dip distinctive.

EFFECTS OF ARSENICAL DIPS ON CATTLE.

The effects of the dips upon the cattle in the various experiments were almost invariably slight.

No constitutional symptoms were observed except in one experiment in which a dip containing 0.476 per cent of arsenic trioxid was used, and these may have been secondary to severe skin lesions. The calf dipped in this strong solution lost considerably in weight and did not begin to recover from the effects of the dip until about a month after dipping. In another experiment a calf dipped in a still stronger solution (0.495 per cent) of arsenic trioxid showed no signs of injury other than slight skin injury. Cattle, not infested with ticks, dipped repeatedly in a dip containing an equivalent of about 0.22 per cent arsenic trioxid at intervals of two and three weeks, gained less in weight than other uninfested cattle kept under the same conditions undipped, but it is uncertain whether this difference was due to the dipping.

[1] It has been found by Mr. Fuller, of the Biochemic Division of this bureau, that under certain conditions the sodium arsenite in an arsenical dip becomes more or less completely oxidized to sodium arsenate, this change occurring after the lapse of several weeks. (See Bureau of Animal Industry Circular 182.) In the experiments discussed in the present paper, unless otherwise stated, the arsenic in the dips used was in solution as arsenite, and was known so to be either because the dips were used fresh or because they were afterwards proved by chemical analysis to be unoxidized.

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In all cases in which cattle were dipped or sprayed once or twice in arsenical dips containing an equivalent of from 0.16 to 0.24 per cent of arsenic trioxid, the injurious effects observed were confined to the action of the dips upon the skin, and scarcely ever was this action more than very mild, though in some cases the animals were treated in hot weather when the injurious effects from dipping are especially likely to appear. The signs of the effects of dipping on the skin in various instances became evident in from 3 to 9 days after the treatment, at which time a more or less well-marked epidermal exfoliation or dandruff-like peeling of the superficial layers of the skin appeared, confined as a rule to the dewlap, neck, escutcheon, inner side of thighs, and scrotum. No marked inflammation preceded the exfoliation, though occasionally a slight irritation of the skin in places was observed.

In a number of cases the skin became somewhat thickened on certain parts of the body, namely, on the escutcheon, inner side of the thighs, dewlap, and neck. Rarely was cracking of the thickened skin observed. In one experiment in which cattle were sprayed once with an arsenical solution containing an equivalent of about 0.17 per cent of arsenic trioxid, to which had been added 10 per cent of crude petroleum emulsified with soap, rather severe skin injury was observed in the case of some of the animals, consisting in exfoliation, thickening, and cracking of the skin, with evident soreness, which caused the animals to become stiff and lame. These effects were apparently largely due to the oil, as the skin of cattle sprayed in the same dip before the addition of the crude petroleum showed scarcely any signs of injury. In the case of a few animals in some of the experiments a slight loss of hair accompanied the exfoliation. Bulls seemed to be more liable to skin injury than cows and steers. The effects of a second dipping, so far as observed, were always less than those of the first. When fresh exfoliation occurred as a result of a second dipping given within two weeks after the first, it first became noticeable in from 8 to 13 days after the second dipping.

In this connection it should be noted that it is a matter of common observation, and shown very clearly in many of the experiments discussed in this paper, that there is a great difference in the susceptibility of individual animals to the effects of dips applied in the same way and under similar conditions. The skin affections produced by a dip appear also to depend on the method employed in applying it. Watkins-Pitchford[1] has found that an arsenical dip which is satisfactory from the standpoint of its effects on the skin when used as a spray is entirely too strong when used as a dip.

[1] Natal Agricultural Journal, Pietermaritzburg, vol. 12, no. 4, 1909, pp. 436–459; vol. 15, no. 5, 1910, pp. 577–602.

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In our own experiments, cattle dipped ten times with an interval of one week between the first two dippings and with an interval of two weeks between the second and third and succeeding dippings, and cattle dipped seven times at intervals of three weeks, showed scarcely any evidences of the effects of the dip upon the skin. The dip used in this experiment originally contained sodium arsenite equivalent to 0.217 per cent arsenic trioxid, but at some time between three weeks and three months after the first dipping the sodium arsenite had become largely oxidized to sodium arsenate. It is probable that sodium arsenate is less active on the skin than sodium arsenite, hence it is possible that if a freshly made arsenical dip had been used at each dipping the repeated applications might have had more effect upon the cattle, though it should be noted that at the tenth dipping of one lot of cattle, and the seventh dipping of the other lot, a freshly prepared dip, containing an equivalent of 0.22 per cent arsenic trioxid, was used without producing any noticeable skin injury.

In one experiment in which a dip was used containing an equivalent of 0.222 per cent arsenic trioxid with some soap, the effects on the skin, though not serious, were somewhat more marked than those usually observed following the use of a simple arsenic-soda-pine tar dip containing the same percentage of arsenic. The effects of a proprietary dip, which contained soap and other ingredients of minor importance in addition to arsenic, as observed in two experiments, were apparently somewhat greater than those resulting from the above-mentioned dip containing soap or the ordinary arsenic-soda-pine tar dip.

The following conclusions may be drawn from the various experiments as to the effects of arsenical dips upon cattle:

Cattle may be safely dipped or sprayed with an arsenical dip containing an equivalent of 0.24 per cent arsenic trioxid or less, and the treatment once repeated seven or more days later,[1] the only injury to be expected as a rule being more or less epidermal exfoliation and sometimes slight soreness or tenderness of the skin local in character.

It is understood in stating the foregoing conclusions that accidents resulting from a lack of proper precautions to avoid the drinking of the dip by cattle are excluded from consideration, and it should also be noted that cattle are liable to suffer severely after dipping, especially in hot weather, if driven long distances, or even if allowed to run short distances so that they become overheated. This latter fact is stated on the basis of observations made by various persons who have had considerable practical experience in the use of arsenical dips. On the whole, however, in view of the hundreds of thousands of cattle on farms and ranches which have been treated with arsenical

[1] If many treatments are given, the intervals between treatments should not be less than two weeks.

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dips under all sorts of conditio s, the number of cases of injury reported has been remarkably small.

In this connection it is of interest to note that Watkins-Pitchford[1] in observations made in South Africa finds that dipping work oxen every fifth day in an arsenical dip called the "laboratory dip" (containing as its essential ingredient 8½ pounds of arsenite of soda, 80 per cent arsenic, to 400 gallons (imperial)[2] of water) does not interfere in any way with cattle being worked regularly.

EFFECTS OF ARSENICAL DIPS ON TICKS.

The experiments discussed in the present paper have fully confirmed the observations of various investigators and practical users of arsenical dips, who have found that ticks are very sensitive to arsenic. Little is known as to the avenue by which arsenic enters the body of ticks when arsenical dips are used.

Mr. W. F. Cooper[3] states that he has proved "that on the application of an arsenical solution to the skin of a beast, the arsenic penetrated the skin and was to be found in all the tissues of the beast, and further, that this took place very rapidly." In his experiments a considerable amount of arsenic was found in blood taken from the heart as early as 18 hours after dipping. Contrary to the results obtained by Mr. Cooper, a committee appointed by the board of health, Natal, South Africa,[4] has found that no trace of arsenic was present in the muscles, liver, kidneys, or stomach of cattle dipped repeatedly at short intervals in arsenical solutions. With regard to the presence of arsenic on the coat and in the skin of animals treated regularly with an arsenical dip, Watkins-Pitchford[5] has furnished some interesting observations. He appears to have shown by analysis of samples of skin a foot square from animals that have been dipped or sprayed regularly that there is an accumulation of arsenic in the skin up to a certain maximum amount which is rather constant, and can not be materially raised by shortening the interval between treatments. He believes that there is not merely a mechanical deposition of arsenic in the skin, but that the amount is controlled by vital processes, any excess of arsenic beyond a certain amount being rapidly taken up by the blood and eliminated in the urine. The amount of arsenic in the hair and scurf is raised by spraying the skin immediately after death, while that in the skin, according to the statement of the author, is not; but the evidence presented on this last point is not complete. It was also found that the amount

[1] Natal Agricultural Journal, Pietermaritzburg, vol. 12, no. 4, 1909, pp. 436–459; vol. 15, no. 5, 1910, pp. 577–602.

[2] One imperial gallon equals approximately 1.2 U. S. gallons.

[3] Journal of Agricultural Science, Cambridge, vol. 3, part 3, p. 288. 1910.

[4] Agricultural Journal of the Cape of Good Hope, vol. 37, no. 6, Dec., 1910, p. 699.

[5] Natal Agricultural Journal, Pietermaritzburg, vol. 15, no. 3, 1910, pp. 312–329.

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of arsenic in the hair and scurf of a square foot of skin was always greater than that in the skin itself.

The same author has shown by experiments, which, however, are rather limited, that animals that have been treated with an arsenical dip are poisonous to ticks; that this toxicity increases with the number of treatments, and that it is less in regularly treated animals, the longer the period elapsing after the last treatment. It was also found that when infested animals regularly treated, and others not thus treated, were dipped, the ticks on the former perished much more quickly than on the latter.

That ticks are not killed by arsenic present in the blood, the author claims to have shown by spraying an animal all over except on a certain area where ticks had been placed, in which case the ticks remained unaffected. On the other hand, the poisonous effects do not appear to be due to a simple deposition of arsenic on the skin, because, when ticks are permitted to attach to an area of skin, on a regularly treated animal, which has been previously shaved and washed to remove any arsenic on the surface, they nevertheless succumb.

Some interesting observations were also made with regard to the persistence of arsenic in the hair. In one instance arsenic was found in the hair six months, and in another seven months, after treatment. A case is referred to in which 3 inches of rainfall did not lower appreciably the amount of arsenic in the coat.

Although Watkins-Pitchford's observations indicate that arsenic accumulates in the skin of cattle when they are dipped repeatedly, it is certain that the action of arsenical dips is not entirely dependent upon the arsenic which ticks may obtain from the skin, for the reason that ticks removed from cattle immediately after dipping may afterwards exhibit evidences of having been acted upon by the dip. Our slight knowledge of the mechanism of the action of arsenic upon ticks, therefore, allows only the general statement that when arsenical dips are used the poison enters the bodies of the ticks in one or more of the following ways, namely, through the mouth, through the breathing pores, through other openings of the body, or by absorption through the cuticle, with the corollary that the poisonous action of these dips upon ticks is certainly not entirely dependent upon the arsenic which may be ingested from the skin of cattle after treatment with arsenical dips.

FEMALE TICKS.

It was noted in the various experiments that, as a rule, after cattle had been treated with arsenical dips the number of female ticks maturing became rapidly less day by day, and that it was exceptional to find any engorged ticks present a few days after the

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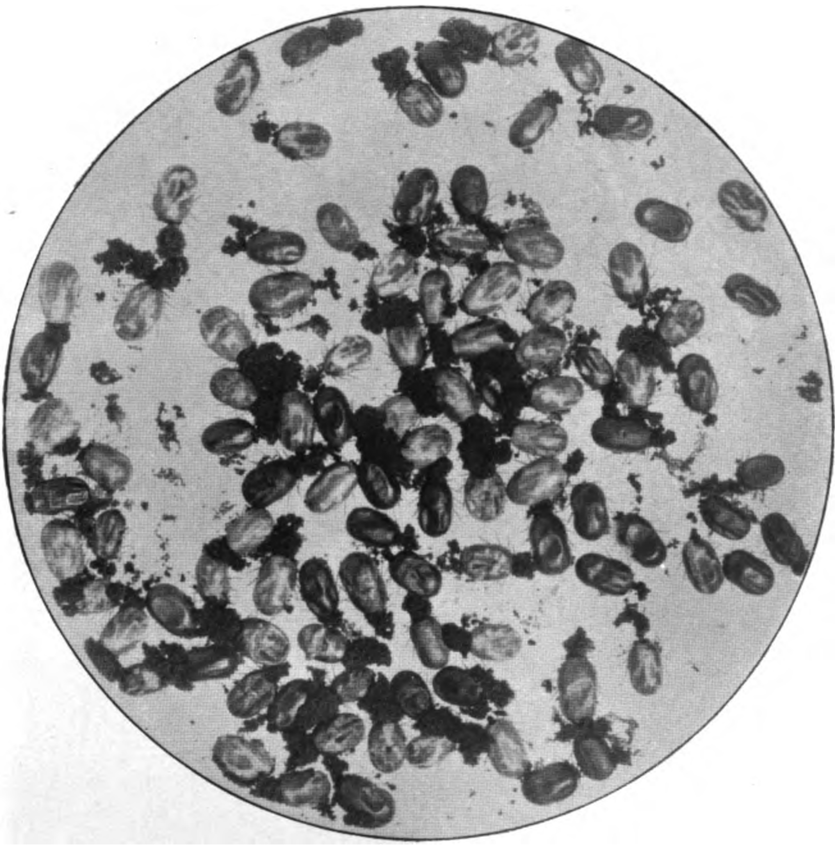

ONE HUNDRED AND TWENTY-THREE ENGORGED FEMALE TICKS.

Experiment No. 5. After dipping in an arsenical solution containing an equivalent of less than 0.22 per cent arsenic trioxid. The average weight of eggs per tick deposited by this lot (including all ticks whether they oviposited or not) was 23.4 milligrams, and none of them hatched. Two-thirds natural size; from a photograph taken 24 days after dipping. Compare Plate XVII, showing untreated ticks collected on the same date as those shown in this plate.

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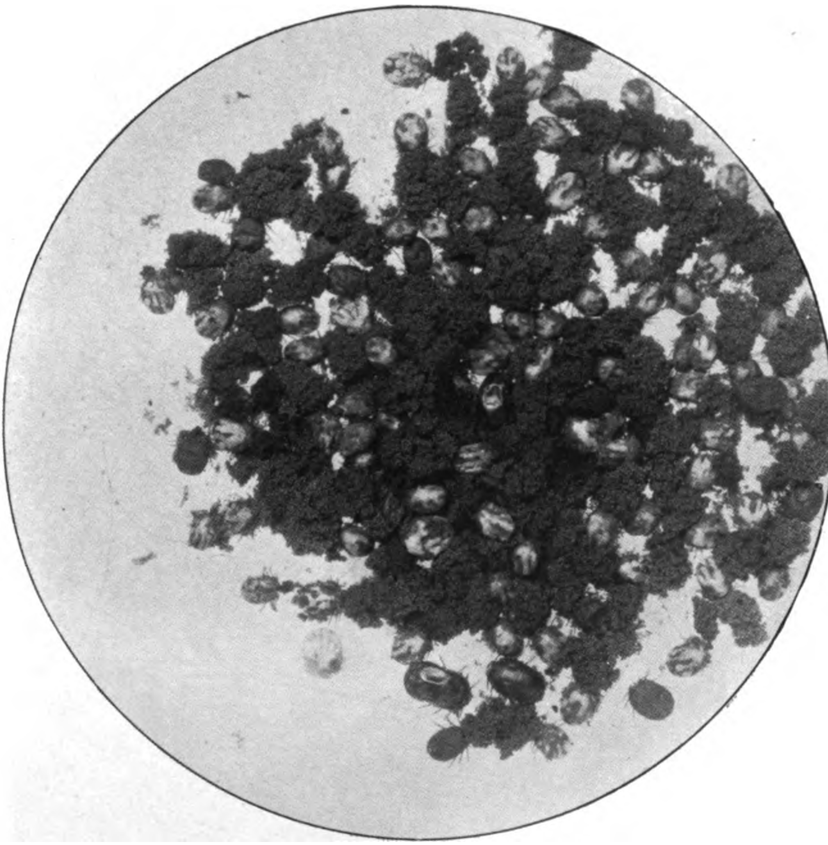

ONE HUNDRED AND FIVE ENGORGED FEMALE TICKS.

Experiment No. 5. Collected on the same date as those shown in Plate XVI and kept under the same conditions but not dipped. The average weight of eggs per tick deposited by this lot (including all ticks whether they oviposited or not) was 127.5 milligrams, and practically all of them hatched. Two-thirds natural size; from a photograph taken on the same date as that of the ticks shown in Plate XVI.

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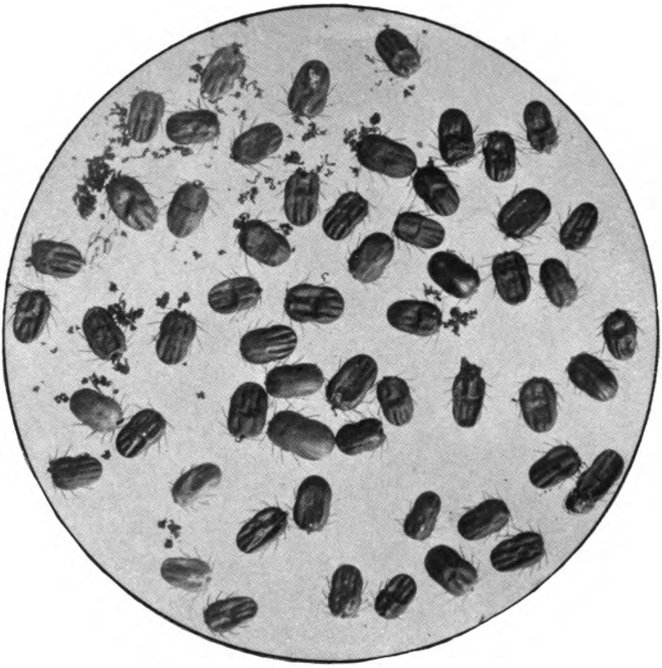

FIG. 1.—FIFTY-SEVEN ENGORGED AND NEARLY ENGORGED FEMALE TICKS.

Experiment No. 11. Collected from a calf immediately after dipping in an arsenic and pine-tar solution containing an equivalent of 0.215 per cent arsenic trioxid. The average weight of eggs per tick deposited by this lot (including all ticks whether they oviposited or not) was 1.3 milligrams, and none of them hatched. Natural size; from a photograph taken 18 days after collection.

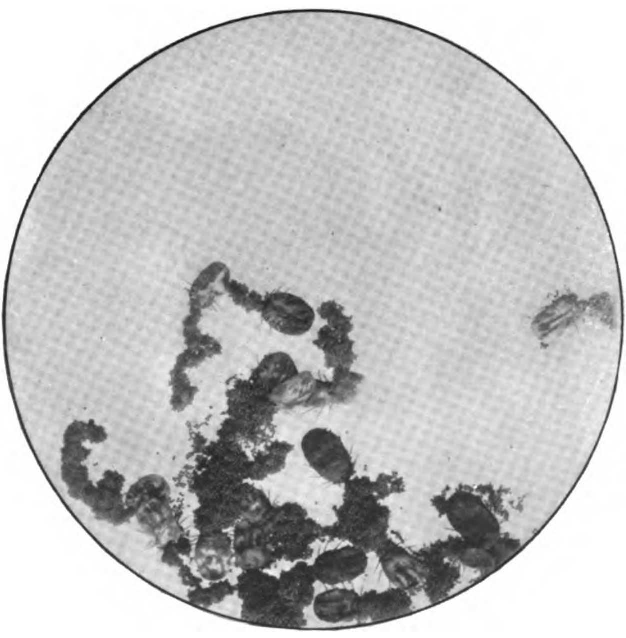

FIG. 2.—SEVENTEEN ENGORGED FEMALE TICKS.

Experiment No. 11. Collected from an undipped calf on the same date as those shown in Fig. 1, and kept under the same conditions. The average weight of eggs per tick deposited by this lot (including all ticks whether they oviposited or not) was 52.7 milligrams, and 97 per cent of them hatched. Natural size; from a photograph taken 18 days after collection.

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treatment. It is therefore evident that after treatment with an arsenical dip the vast majority of the young adult females die before they reach the engorged stage, and that the younger they are the less likely are they to survive and become engorged.

In six experiments the cattle were found to be free from engorged ticks three to five days after the first treatment; in four other experiments they were free seven to nine days after treatment; in another they were nearly free five days after treatment; in another experiment all that were examined were free from engorged ticks eight days after treatment; and in two other experiments the cattle were nearly free from engorged ticks eight days after treatment. An idea of the marked effect of treatment upon female ticks may be obtained from the observations made in one experiment (No. 5), in which a record was kept of the number of ticks which reached the engorged stage on two calves after dipping in an arsenical dip containing an equivalent of 0.16 per cent arsenic trioxid. This dip contained considerably less arsenic than the dips usually employed. A third calf was kept under observation undipped, and the number of ticks maturing on this animal from day to day was recorded as in the case of the two dipped calves. On one of the dipped calves 1,340 ticks and on the other 1,907 ticks reached engorgement during the first week after dipping. From the undipped calf 968 engorged ticks of which a record was kept were collected during the same period. Subsequent to the first seven days after dipping only 67 and 37 ticks, respectively, reached engorgement on the dipped animals, whereas more than 1,000 reached full maturity on the untreated calf.

A question of great importance is that of the fate of the ticks which reach engorgement and fall from cattle subsequent to treatment with arsenical dips. In order to obtain data bearing upon this question engorged ticks were collected from the cattle in the various experiments immediately after treatment and on successive days thereafter, and kept under observation. Observations were likewise made upon ticks removed on corresponding dates from untreated cattle. These ticks were kept under the same conditions as those from the treated cattle, and thus served as "controls" or "checks" upon the latter. Excluding from consideration one experiment (No. 5, referred to in the preceding paragraph), in which an unusually weak arsenical dip was used, about 70 lots of ticks, varying in number from 1 to 100 each, were removed from treated cattle in the various experiments. A somewhat smaller number of lots of ticks from untreated cattle were kept under observation as controls, as in several cases the same lot of ticks from untreated cattle was utilized as a control for several lots from treated cattle. Reviewing the observations recorded relative to the ticks removed from cattle, it may be

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noted that whereas in many of the lots from treated cattle all of the ticks died without ovipositing, in most cases some of the ticks deposited eggs, the percentage of ticks ovipositing usually being low but in rare instances as high as 100 per cent. In the control lots the number of ticks ovipositing was almost always 100 per cent.

A marked difference is also apparent with reference to the number of eggs deposited by ticks from treated and from untreated cattle. Ticks from treated cattle which survived to deposit eggs nearly always deposited a much smaller number than ticks from untreated cattle.

Moreover, not only were the eggs deposited by ticks from treated cattle less numerous, but they rarely hatched. On the other hand, in only one instance among the control lots did all the eggs fail to hatch. This was due to the lack of proper moisture, and the same circumstance explains the rather low percentage of eggs which hatched in several other control lots. In great contrast to the high percentage of eggs hatching among those deposited by ticks from untreated cattle is the fact that out of approximately 70 lots of ticks[1] from treated cattle only 4 lots deposited eggs which hatched. The data concerning these 4 lots of ticks are as follows: Three ticks, removed from cattle immediately after spraying with a dip containing an equivalent of 0.217 per cent arsenic trioxid but in which the sodium arsenite had become largely oxidized to sodium arsenate, deposited eggs of which 5 per cent hatched. Twenty out of 48 ticks removed from cattle 2 days after dipping in a dip containing an equivalent of 0.202 per cent arsenic trioxid deposited eggs of which 1 per cent hatched, and in the same experiment 10 out of 22 ticks removed 3 days after dipping deposited eggs of which 1 per cent hatched. The fourth case was that of a tick removed from a calf 4 days after dipping in a dip containing an equivalent of 0.215 per cent arsenic trioxid. This tick deposited numerous eggs, about half of which hatched.

Judging from these results it would appear that the hatching of eggs deposited by ticks which survived treatment with arsenical dips is a rather rare occurrence. Furthermore, it has been noted that the larvæ from eggs deposited by females which have been subjected to arsenical solutions are frequently in such a weakened condition that they can not emerge from the eggshell, or become lodged in the opening of the ruptured shell and fail to extricate themselves, or show such slowness of movements after emerging as to make one believe that they could not effect a successful attachment after reaching a

[1] This includes all of the different lots of ticks collected from the treated cattle in the various experiments, with the exception of Experiment No. 5, which is omitted from consideration on account of the fact that the dip used contained an unusually low percentage of arsenic.

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host, a condition of the larvæ which has also been noticed in the case of eggs subjected to unfavorable conditions, such as a low relative humidity and low temperatures.

The effects obtained when engorged ticks are taken from untreated cattle and immersed in arsenical dips for 2 minutes are very much the same as those observed when the ticks are removed from cattle after treatment. Sixteen lots of 15 to 123 ticks each were thus treated. In 5 of the lots none of the ticks oviposited; in the remainder 3.4 to 100 per cent deposited eggs. In each of the control lots, composed of 8 to 105 ticks each, 95 to 100 per cent of the ticks oviposited. The number of eggs deposited by each treated tick which survived to oviposit averaged much less than in the case of the untreated ticks. In the case of only 2 lots of treated ticks did any of the eggs hatch. These 2 lots were treated with a neutral and an alkaline solution, respectively, of sodium arsenate equivalent to 0.22 per cent arsenic trioxid. One and 2 per cent, respectively, of the eggs hatched. In the control lot 99 per cent of the eggs hatched. In view of the close correspondence between the results of the experiments in which engorged ticks were kept under observation after their removal from treated cattle, and results of the experiments in which engorged ticks were removed from untreated cattle and kept under observation after immersion for a short time in arsenical dips, it is evident that experiments of the latter kind are useful in that they furnish an indication of the efficacy of arsenical dips so far as engorged or nearly engorged ticks are concerned.

No more is known as to the exact way in which the poisonous action of arsenic takes effect upon the eggs of ticks than is known as to the way in which it takes effect upon the ticks themselves. The fact that the eggs have been injured becomes apparent soon after deposition, sometimes immediately. Those which have been injuriously affected are then readily distinguished by their dark color and shriveled condition.

The two series of photographs given in Plates XVI to XXI, in which the appearance of treated and untreated ticks may be compared, show very strikingly some of the effects of arsenical dips upon ticks and their eggs.

Summing up the numerous observations which have been made as to the effects of arsenical dips upon engorged, partially engorged, and young female ticks, it will be noted that cattle were generally free from engorged ticks within a week after treatment; that of the ticks which were present in the engorged stage at the time of treatment or which subsequently reached the engorged stage only a few, as a rule, deposited eggs; that the number of eggs deposited was much less than normal, and that very few of the eggs hatched.

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MALE TICKS.

Very few male ticks were found alive on cattle later than a day or two after treatment, and it is probable that most of these were ticks which were in the nymphal stage at the time of treatment. It may therefore be concluded that arsenical dips are highly efficacious so far as the destruction of male ticks is concerned.

NYMPHS AND LARVÆ.

It was found in the experiments with arsenical dips that the vast majority of nymphs were killed by a single treatment. In several experiments, however, some of the nymphs survived and afterwards molted. Supplementing the observations made on nymphs in situ on cattle after treatment, observations were made on nymphs removed from their hosts subsequent to treatment after the lapse of varying periods of time. These observations showed that in the case of 12 lots none of the nymphs molted; and that in the case of 4 lots 8 to 50 per cent molted. Nymphs removed from untreated cattle and kept under the same conditions as controls usually molted, 10 to 100 per cent in 9 lots, only 1 lot being collected in which all the nymphs failed to molt.

No instance was observed in any of the experiments of the survival of ticks in the larval stage after a single treatment with an arsenical dip. While the possibility of such an occurrence must be admitted, it seems certain that the survival of larvæ after treatment with an arsenical dip of proper strength would be very exceptional, and for practical purposes it seems safe to assume, until evidence can be obtained to the contrary, that arsenical dips are entirely efficacious so far as concerns ticks in the larval stage.

PROTECTIVE ACTION OF ARSENICAL DIPS.

Little evidence has been obtained as to the degree of protection against reinfection afforded by arsenical dips or as to the length of time after treatment that such protective action continues. It seems, however, that cattle are protected from reinfection, at least to some extent, during several days after treatment. The results obtained by Watkins-Pitchford with regard to the accumulation of arsenic in the skin and the toxicity of regularly treated animals, already referred to, would seem to show that an arsenical dip may protect cattle considerably against reinfection. Owing to the uncertainty as to this point, however, it is unsafe to place any reliance upon the protective action of arsenical dips, and it should be assumed that treated cattle are liable to reinfection if exposed at any time after the arsenical solution has become dry upon their bodies.

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GENERAL SUMMARY OF RESULTS OF EXPERIMENTS.

Arsenical dips which do not contain more than 0.24 per cent arsenic (reckoned as arsenic trioxid) may be safely used for dipping cattle, provided proper precautions are observed.

Larval ticks are killed by a single application of arsenical dip of proper composition.

Most nymphal ticks are killed by a single application of arsenical dip, but some may survive and afterwards molt. No instance has been observed in which nymphs have survived and reached maturity after two treatments 7 to 10 days apart.

Adult male ticks rarely survive one treatment and have never been observed to survive two treatments with arsenical dips of proper strength.

Adult female ticks commonly remain alive on cattle for several days after a single treatment with arsenical dip. The younger the adult ticks are the less likely they are to survive. Some of those which are engorged at the time of treatment, or which afterwards reach engorgement, may deposit eggs. The number of eggs deposited by such ticks is less than normal and hatching rarely occurs.

Cattle become free or practically free from engorged ticks within a week after a single treatment.

Cattle may be rendered free from ticks in all stages by dipping twice in an arsenical dip of proper strength, with an interval of 7 to 10 days between dippings.

PRACTICAL SIGNIFICANCE OF THE RESULTS OF EXPERIMENTS WITH ARSENICAL DIPS.

In considering the practical application of the results of the experiments with arsenical dips it should first of all be noted that though arsenic has a marked effect on all stages of the ticks, none of the arsenical dips tested has proved sufficiently efficacious to insure a tick-free condition of cattle by means of a single application of the dip. As we know them at present, therefore, arsenical dips must be considered as falling short of the ideal of perfect efficacy.

The question then arises whether with their admitted imperfections arsenical dips may be used with advantage in the eradication of ticks. This question may be unhesitatingly answered in the affirmative. Arsenical dips are undoubtedly of very great value in tick eradication, and, all things considered, no better dip for the destruction of ticks has yet been discovered. This has been demonstrated not only by experimental work but also by the results obtained from an extensive practical use of arsenical dips by many owners of live stock in Texas, Oklahoma, and California.

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The practical application of the results of the experiments with arsenical dips may be considered under several headings as follows:

1. Composition of the dip.
2. Method of application.
3. Number and frequency of applications.
4. Handling the cattle.

COMPOSITION OF THE DIP.

The investigations thus far carried out have not been extensive enough to enable a definite statement to be made as to the minimum percentage of arsenic required to give an arsenical dip a sufficiently high degree of efficacy to make it of practical value. Moreover, it is probable that under some conditions a stronger dip will be necessary to obtain satisfactory results than under other conditions, and it is probable also that in many cases a rather weak dip may be used to advantage when a stronger dip would be undesirable on account of possible injurious effects on cattle—for example, in the case of repeated treatments during very hot weather. The experiments indicate that dips containing as high as 0.24 per cent arsenic (reckoned as arsenic trioxid) may be used without unduly injuring cattle. It has been assumed that this is the maximum strength at which dips containing arsenic in the form of sodium arsenite or potassium arsenite may be used without too great risk of injury. In view of the fact that in one experiment an arsenical dip containing somewhat less than an equivalent of 0.2 per cent proved less efficacious than dips in other experiments which contained an equivalent of approximately 0.2 per cent or more of arsenic trioxid, 0.2 per cent was selected as an arbitrary minimum limit. The mean between the minimum and maximum limits, or 0.22 per cent, may therefore be taken as an arbitrary standard; and a dip to have the maximum degree of efficacy, so far as this may be attained without great risk of injury to cattle, should not deviate more than very slightly above or below this standard of 0.22 per cent.

The arsenical dips commonly used and with special reference to which most of the experimental work has been done are based on a modification of Dr. Mayo's formula given in the introduction of the present article. Directions for preparing such a dip so that it will conform to the standard which has been selected are as follows:

In preparing each 500 gallons of the standard arsenical solution there shall be used 10 pounds of finely powdered white arsenic containing not less than 99 per cent of arsenic trioxid, 25 pounds of sal soda, and 1 gallon of pine tar. The arsenic and sal soda shall be boiled together in not less than 25 gallons of water for 15 minutes,

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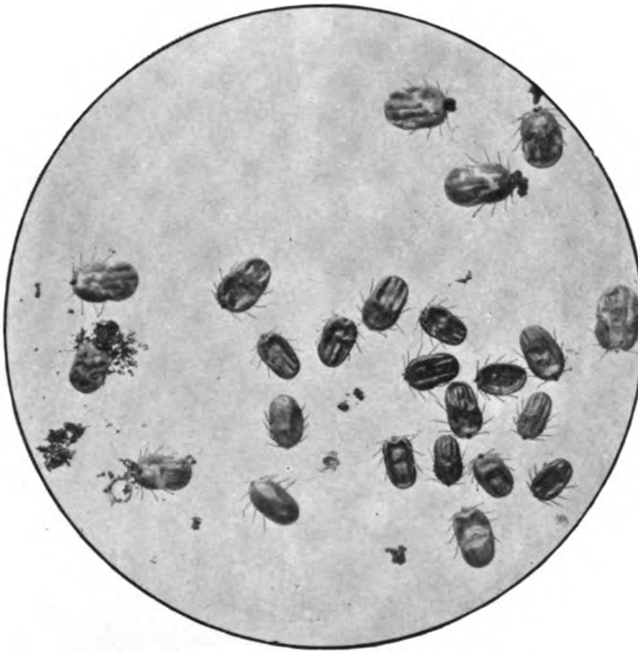

FIG. 1.—SEVEN FULLY ENGORGED AND SEVENTEEN PARTIALLY ENGORGED FEMALE TICKS.

Experiment No. 11. Collected from a calf the next day after dipping in an arsenic and pine-tar solution containing an equivalent of 0.215 per cent arsenic trioxid. The average weight of eggs per tick deposited by this lot (including all ticks whether they oviposited or not) was 2.1 milligrams, and none of them hatched. Natural size; from a photograph taken 17 days after collection.

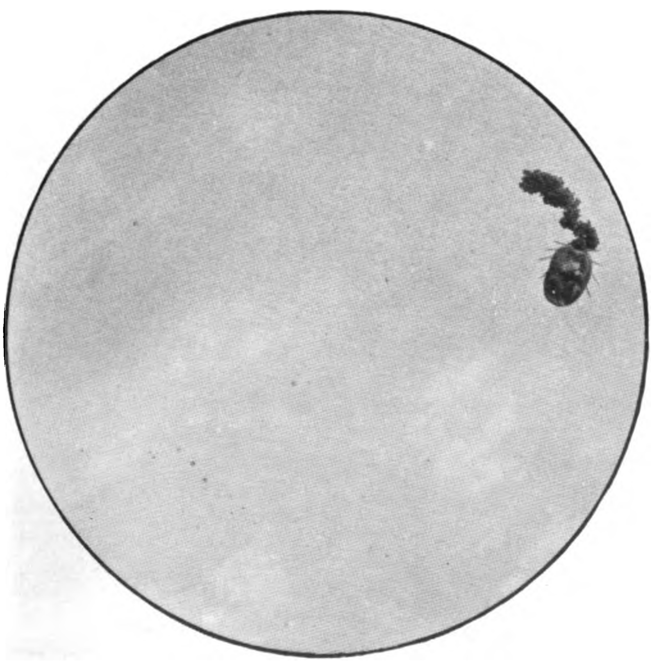

FIG. 2.—ENGORGED FEMALE TICK.

Experiment No. 11. Collected from an undipped calf one day earlier than those shown in Fig. 1, and kept under the same conditions. The weight of eggs deposited by this tick was 42.6 milligrams, and 40 per cent of them hatched. Natural size; from a photograph taken 18 days after collection.

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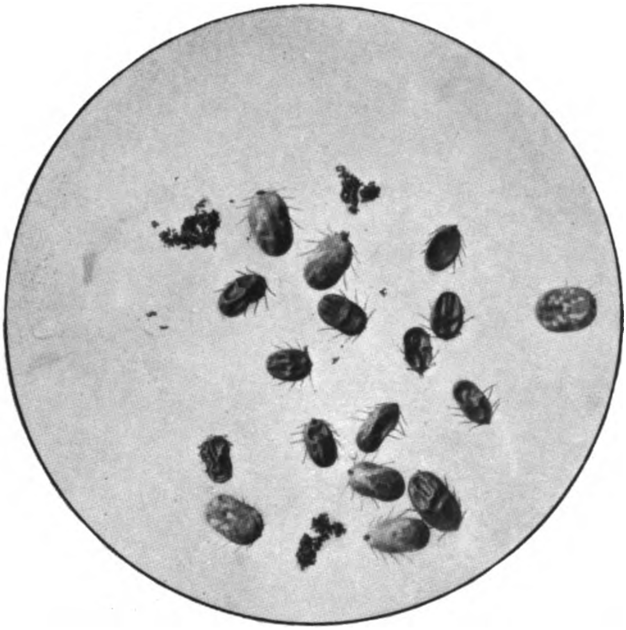

FIG. 1.—SEVEN FULLY ENGORGED AND TEN PARTIALLY ENGORGED FEMALE TICKS.

Experiment No. 11. Collected from a calf two days after dipping in an arsenic and pine-tar solution containing an equivalent of 0.215 per cent arsenic trioxid. The average weight of eggs per tick deposited by this lot (including all ticks whether they oviposited or not) was 3 milligrams, and none of them hatched. Natural size; from a photograph taken 16 days after collection.

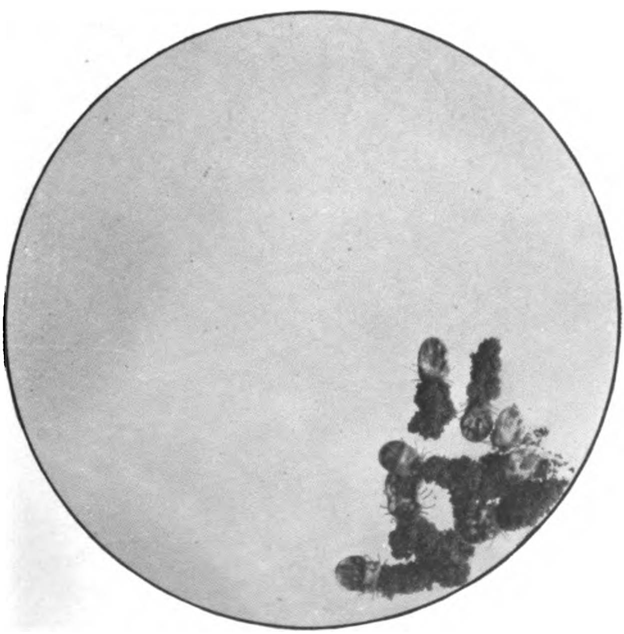

FIG. 2.—FIVE FULLY ENGORGED AND THREE PARTIALLY ENGORGED FEMALE TICKS.

Experiment No. 11. Collected from an undipped calf one day later than those shown in Fig. 1, and kept under the same conditions. The average weight of eggs per tick deposited by this lot (including all ticks whether they oviposited or not) was 58.6 milligrams, and 99 per cent of them hatched. Natural size; from a photograph taken 15 days after collection.

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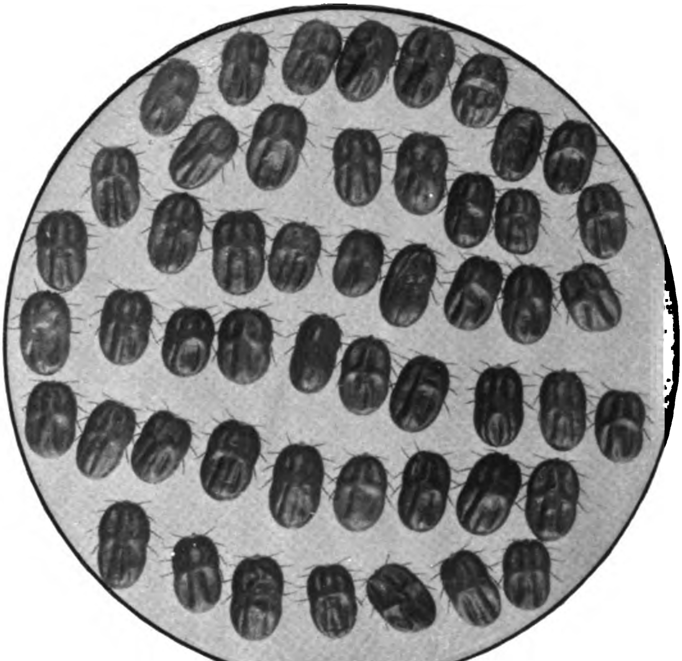

FIG. 1.—FIFTY-ONE ENGORGED FEMALE TICKS.

Experiment No. 12. After dipping in an arsenic and pine-tar solution containing an equivalent of 0.215 per cent arsenic trioxid. All of them died without depositing eggs. Natural size; from a photograph taken 4 days after dipping.

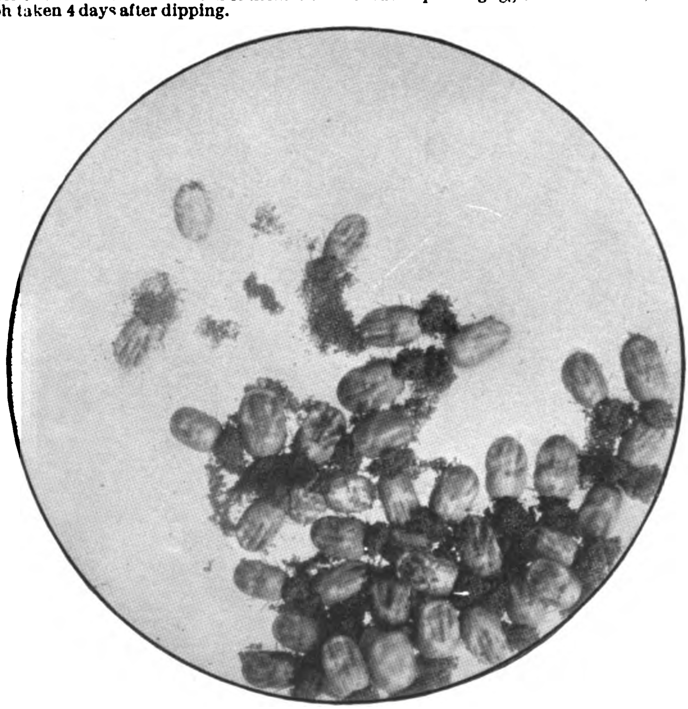

FIG. 2.—FORTY ENGORGED FEMALE TICKS.

Experiment No. 12. Collected from an undipped calf on the same date as those shown in Fig. 1 and kept under the same conditions, but not dipped. The average weight of eggs per tick deposited by this lot (including all ticks whether they oviposited or not) was 53.4 milligrams, and 60 per cent of them hatched. Natural size; from photograph taken on same date as that of ticks shown in Fig. 1

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or longer if necessary to effect complete solution of the arsenic. Before the pine tar is added the temperature of the solution shall be reduced to 140° F. This may be done by the addition of cold water. The pine tar shall then be added in a small stream while the solution is thoroughly stirred, after which the solution shall be immediately diluted with clear water sufficient to make 500 gallons of dip.

The cooling of the arsenic and sal-soda solution before the addition of the pine tar is important, as otherwise an imperfect mixture having a curdled appearance is likely to result.

It has already been noted that the quantity of sal soda used in the above formula is in excess of the amount actually needed to combine with all the arsenic, but until it can be shown that the efficacy of the dip in no way depends upon the presence of this excess of soda the proportionate amount of sal soda should not be reduced.

In cases wherein it is considered expedient to use a weaker dip the amount of arsenic may be reduced to 8 pounds per 500 gallons of dip, but for all official dippings the standard amount of 10 pounds to 500 gallons is required.

METHOD OF APPLICATION.

There are two practicable methods of applying arsenical dips, namely, spraying and dipping.

Spraying is not practicable, except in the case of very small herds, unless a spraying machine is used. Spraying machines, however, have proved less satisfactory than dipping vats, and it is therefore preferable to use a dipping vat whenever more cattle are to be treated than it is practicable to treat by means of hand spray pumps. Hand spraying is not only more tedious than dipping but it is also less efficacious, as there is not the same certainty of getting a thorough application of the dip even when the greatest care is used. Consequently the dipping vat is much more reliable than the spray pump. It is also more economical whenever more than a very few animals are to be treated.

A dipping vat for cattle should be large enough to afford a bath at least 5¼ feet in depth, and unless the cattle when dipped are held in the bath, the vat should measure at least 40 feet in length at the surface of the dip. If a shorter vat is used, the cattle should be held in the bath at least 15 seconds, better, half a minute, otherwise they are liable to get through the bath without being thoroughly wet to the skin, particularly if the hair is long. A steep slide at the entrance of the vat is desirable in order to insure a plunge which will carry the cattle entirely under the surface of the bath.[1]

[1] Bureau of Animal Industry Circular 183 contains plans and specifications for a short dipping vat suitable for use in ordinary eradication work.

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NUMBER AND FREQUENCY OF APPLICATIONS.

From the data obtained in the experimental work it appears that one treatment with an arsenical dip is insufficient to free cattle from ticks. Subsequent to dipping, ticks continue to reach engorgement and fall from the cattle for several days, and a few nymphs are liable to survive, molt, and possibly continue their development to the engorged stage. On the other hand, no instance has been recorded in which a tick survived two thorough applications of an arsenical dip, given 7 to 10 days apart, and reached fertile maturity, and no larvæ have been observed that have survived a single treatment. The results of the experiments therefore show that cattle may be freed from ticks by two treatments with an arsenical dip.

Although the possibility of ticks surviving two treatments and maintaining the ability to reproduce is always present, the experimental work shows that such an occurrence must be very rare, provided the treatments are thorough; and it is therefore proper to assume, as a working basis, that two treatments are entirely efficacious. Accordingly, it may be stated as a tentative conclusion that after two thorough treatments cattle may be placed on uninfested ground with practically no danger of carrying with them any ticks capable of perpetuating the species. In practice, therefore, when cattle are to be treated for the purpose of ridding them of ticks so that they may be put in uninfested pastures or other tick-free places, they should be dipped twice, with an interval of 7 to 10 days between dippings, using a full-strength arsenical dip.

When cattle are to continue occupying the same pasture or range, the question of the number and frequency of treatments is somewhat different. In this case the rule would be to give repeated treatments at intervals of not over three weeks. Usually more than three weeks and rarely less than this time is required for larval ticks after reaching a host to complete their development to the engorged stage. Hence if cattle were treated every three weeks, practically all of the ticks which they picked up in the meantime would be subjected to treatment. Scarcely any would escape and deposit eggs, and when it is considered that the average number of eggs deposited by each tick surviving treatment would be less than normal and that only a small proportion would hatch, it is evident that the amount of infection of cattle and pastures would greatly and rapidly diminish. Practical experience has demonstrated that complete eradication may be accomplished in this way, the probable explanation being that even if ticks occasionally survive dipping, the number is reduced below the minimum necessary to insure the survival of the species. In other words, in those localities where ticks are established, their fecundity is sufficient for the perpetuation of the species under ordinary conditions, but if the vast majority of individuals that find a host are destroyed, a

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point is soon reached in the numerical reduction below which it is impossible for the species to maintain itself. No set rule can be formulated at present as to the number of times it will be necessary to repeat the treatment with arsenical dip to bring about eradication, but a general rule would be to continue the treatment until the ticks had apparently disappeared, then discontinue it, and if at any time ticks are again observed, resume the treatment, keeping always on the lookout for signs of ticks, just as a physician, in the case of diseases liable to reappear when apparently cured, watches for symptoms indicating a recurrence of the malady.

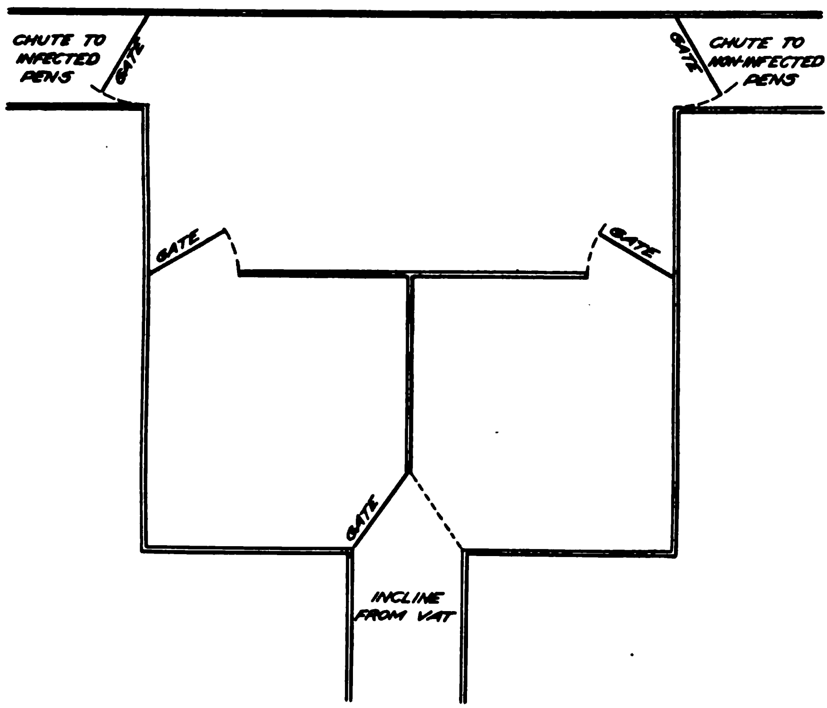

Fig. 22.—Plan of draining pen for cattle after dipping.

HANDLING THE CATTLE.

Cattle should not be treated with arsenical dips when tired or thirsty, and after treatment they should not be allowed to drain in places where the dip dripping from their bodies will form pools which they may drink, or where grass or fodder will become soaked with the dip. For a week or so after treatment, especially in hot weather, cattle should not be driven hard or allowed to run or become overheated. After treatment cattle may, however, be safely shipped by rail, even though they are loaded as soon as their bodies become dry.

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When cattle are to be freed from ticks by two treatments a special arrangement of the dipping plant and yards for handling the cattle is necessary, so that after the second dipping they will not be exposed to reinfection. Certain yards and the alleyways leading to them from the draining pen must be reserved exclusively for cattle which have been twice dipped. These yards and alleyways must be free from infection, and must not be used for any cattle except those which have been twice dipped or are known to be free from ticks. For several days after the first dipping cattle are likely still to harbor ticks able to reproduce; hence it is unsafe to place them in yards or pastures which it is desirable to keep free from infection; and as the second dipping will destroy any larvæ which they may pick up in the meantime, cattle should be kept between dippings in places which are either definitely known to be infested or which it is not desired be kept free from ticks. After the second dipping, however, cattle must be guarded from exposure to infection; hence from the time they leave the draining pens they must not pass over or occupy any places infested with ticks. In order thus to handle cattle either two dipping vats will be required or if the same vat is used for both dippings some arrangement must be made whereby cattle may be brought from the draining pens to their respective yards after the first and second dippings by entirely different routes. This may be readily done if a single draining pen is used, in which case the two alleyways for once-dipped and twice-dipped cattle, respectively, may lead away in different directions from the draining pen. If, however, the common type of double draining pen is used it will be necessary to add a third section (as shown in the diagram, fig. 22) in order that separate routes for once-dipped and twice-dipped cattle may be provided for.

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THE LIVE-STOCK INDUSTRY OF HONDURAS.

By WILLIAM THOMPSON, M. D. C., *Veterinary Inspector*,
AND
JAMES E. DOWNING, *Expert in Stock Investigations.*

In consequence of numerous applications having been made to the United States Department of Agriculture by the Government of Honduras, and also by certain financial interests of New Orleans, La., and other persons interested in the growing of cattle in Honduras, for permission to import Honduran cattle into the United States, particularly via the port of New Orleans, for the purpose of slaughter, and the Government of Honduras being unable to furnish any definite information relative to the existence or nature of the live-stock diseases which might be prevalent in that country, the Secretary of Agriculture determined to send representatives from the Bureau of Animal Industry to make a tour of that country to obtain information at first hand relative to the conditions and prevalent diseases affecting Honduran live stock. Reliable information on this subject was necessary in order to enable the department to determine whether or not the importation of cattle from Honduras could be permitted under the law which prohibits the importation of "neat cattle, sheep, and other ruminants and swine which are diseased or infected with any disease, or which shall have been exposed to such infection within 60 days next before their exportation."[1]

The writers of this article were detailed to make the investigation. Meeting at New Orleans March 22, 1910, we were joined there by Mr. Humberto Ferrari, a member of the consular service of Honduras, who, as representative of the Honduran Government, accompanied us throughout the greater part of our journeys in Honduras in order to act as interpreter and to obtain for us all possible native assistance and cooperation. Mr. Ferrari accomplished this task with tact and courtesy and proved to be a very agreeable and acceptable companion throughout the expedition.

After purchasing part of the outfit required for the expedition, the party sailed from New Orleans March 24, arriving at Puerto Cortes March 29, where we were met by a reception committee of three, who welcomed the party in the name of the governor of the department of Cortes and of the Honduran Government.

[1]Act of Congress approved Aug. 30, 1890 (26 Stat. L., 416), sec. 6.

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From Puerto Cortes we proceeded by rail to San Pedro, where we established our headquarters. On arrival there the first thing to be done was to ascertain what departments were considered as the principal cattle sections, and to formulate an itinerary or outline of the territory which should be traversed to enable us to arrive at definite conclusions respecting the prevalence of animal diseases, including southern cattle fever, which conclusions might be generally applied to the country at large, as it was obviously impossible to visit every hamlet in such a sparsely settled and mountainous country as Honduras. It appeared from the best information obtainable at San Pedro that most of the cattle were to be found in the departments of Choluteca and Olancho, on the southern and southeastern side of the country, with here and there small, scattered valleys or cattle districts.

ITINERARY.

From this it was determined that by making a circuit of the country, passing through the departments of Cortes, Comayagua, Tegucigalpa, Valle, Choluteca, El Paraiso, Olancho, and Yoro, to Trujillo in the department of Colon, thence to La Ceiba, department of Atlantida, and from there back to Puerto Cortes and San Pedro, sufficient territory would be covered to enable us to accomplish the object in view. This plan was adopted and followed, the members of the party being fully satisfied that the extent of the territory covered served the purpose of the expedition and that no further knowledge would be acquired by visiting the smaller departments bordering on Salvador and Guatemala, nor the larger northeastern department of Mosquitia, wild and uninhabited save by Indian tribes. This itinerary made an estimated journey of 1,325 miles on mule back and 50 miles by railroad, and occupied the time from March 29 to July 7, inclusive. On the latter date we left Puerto Cortes for New Orleans. The route traveled and the places where inspections were made are shown in detail on the accompanying map (fig. 23).

TOPOGRAPHY.

The word Honduras signifies in the Spanish language depths, or holes, and it is very appropriately applied to the country of that name, as, excepting small areas on the northern and southern coasts, the entire country is made up of mountains and the depths or valleys lying between. Owing to the sparse population and the natural topographical obstacles, wagon roads and railroads are few, short, and limited to the coast sections, so that practically all travel in that country is performed either afoot or on mule back. The lack of adequate means of internal communication is a great drawback to

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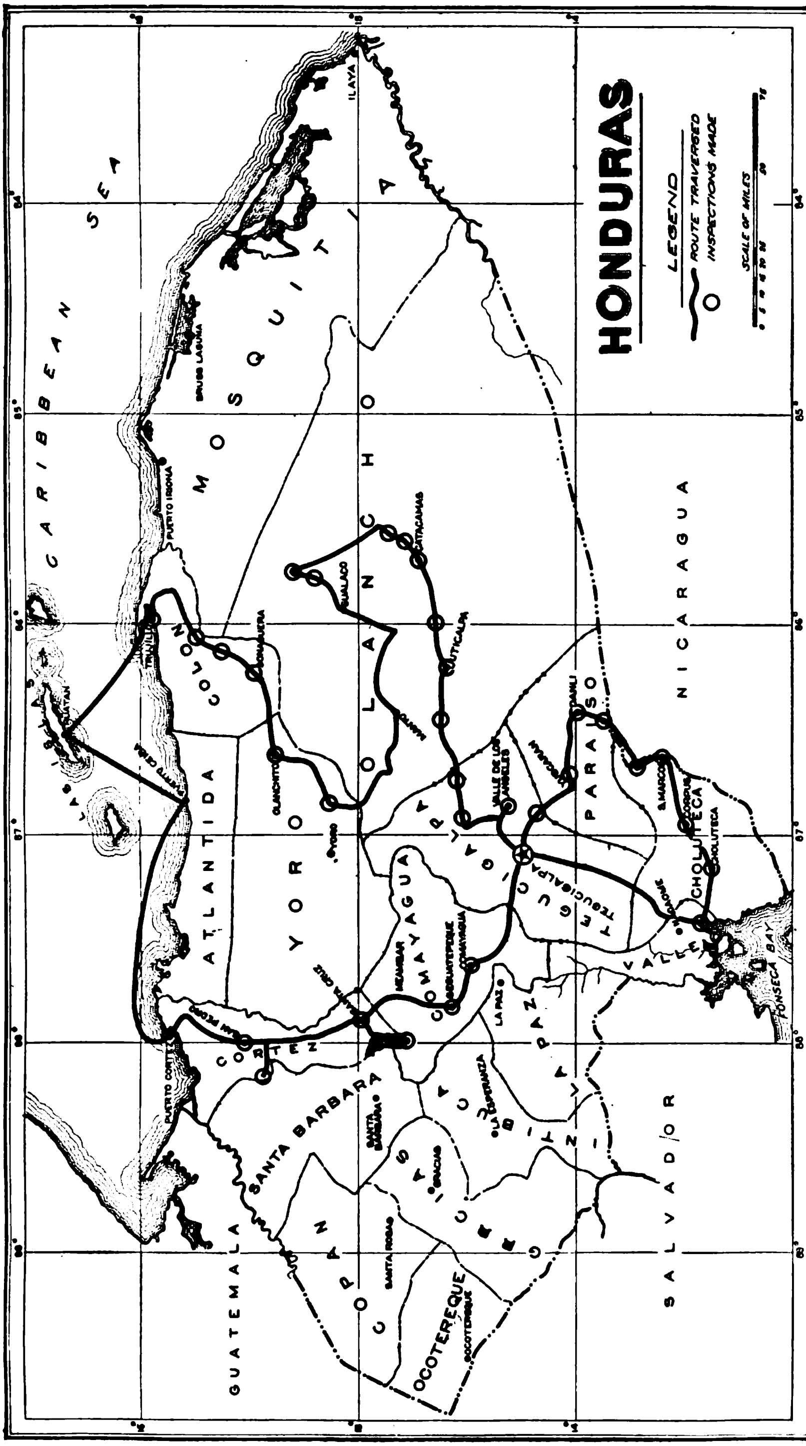

FIG. 23.—Map of Honduras, showing route of Messrs. Thompson and Downing.

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the development of the country. The roads, so called, are mere bridle paths leading over the steepest and roughest mountains, where in some places the path is either so narrow and precipitous or so obstructed by fallen trees or jungle growth as to cause the stranger some apprehension on attempting the difficult and perilous passage. Fortunately, the season was dry at the time of our visit, so that we were not delayed by the slippery trails, swollen streams, and impassable fords which attend the winter or rainy season. The loads that can be carried by the mules, which are the beasts of burden, are small, and progress over the mountainous country is necessarily slow.

After spending some days at San Pedro while assembling and trying out the outfit and mules in making day journeys to ranches in the vicinity, the expedition, or "cattle commission," as it was called in Honduras, left San Pedro April 8 on its journey toward the capital, Tegucigalpa. We went by rail from San Pedro to Pimienta, the end of the line, where we swam the mules across the Ulua River, and ferrying over with our baggage we bade good-by to modern means of transit, resigned, perforce, henceforth to cover the 1,300 miles of our proposed journey on the back of the patient and enduring mule.

CLIMATE, PRODUCTS, AND FORAGE.

Fanned by the northeastern trade winds, Honduras possesses an equable and agreeable climate, particularly in the interior elevated regions. The days are never excessively warm and the nights are invariably cool. Away from the coast one is seldom disturbed by mosquitoes. The country is well covered with timber, mostly pine. Streams and rivulets of clear, pure water abound almost everywhere. The soil is rich, and a variety of products are grown, such as coconuts, bananas, sugar cane, tobacco, corn, coffee, cacao, and rice. Horses, mules, burros, cattle, sheep, goats, and hogs may be found near every habitation. Most of the pasturage consists of native or wild grasses, and during the rainy season forage is abundant everywhere. During the dry season the open range is considerably overstocked, the cattle being at the time of our visit in very poor condition for want of sufficient forage and because of heavy tick infestation. On the coast lands and in the interior well watered valleys, or where irrigation is practicable, permanent fenced pastures are used. These are planted or sown to "guinea" or "para" grass, either of which provides a plentiful and succulent forage. Cattle grazed on these pastures were found to be in excellent condition.

In nearly every part of Honduras there is land suited to the raising of live stock in a limited way. There are two departments, however—Olancho and Choluteca—where three-fourths of the cattle of the country are raised.

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FIG. 1.—MODE OF TRAVELING IN HONDURAS.

FIG. 2.—A MOUNTAIN RANCH IN HONDURAS, WITH NATIVE CATTLE.

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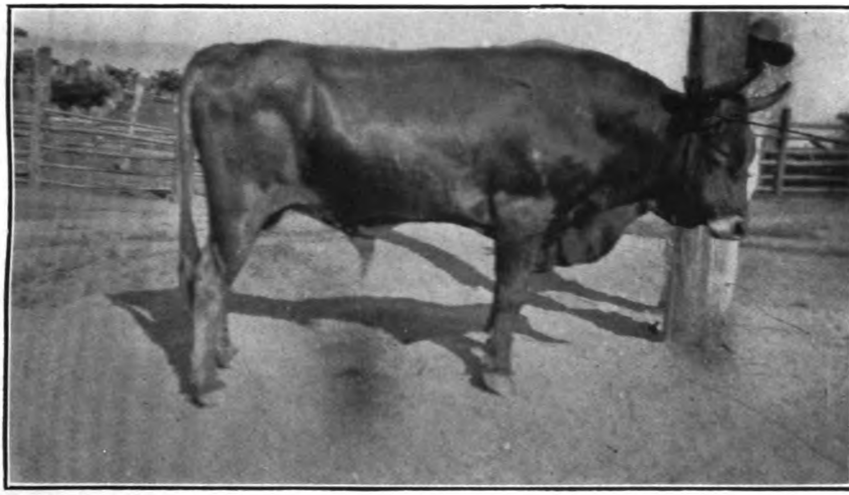

FIG. 1.—NATIVE HONDURAN BULL.

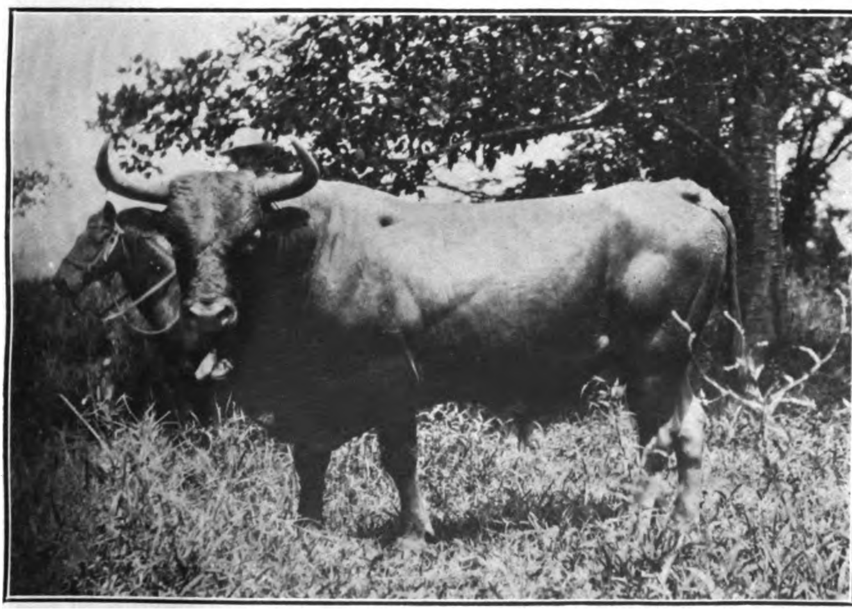

FIG. 2.—HALF-BLOOD SHORTHORN BULL, SHOWING MARKED IMPROVEMENT OVER NATIVE TYPE.

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In soil, grass, and climate, the country is well adapted to stock raising. According to a circular report in 1909 the lowest temperature recorded on the highlands was 42° F., and the highest register on the lowlands was 97° F. The Pacific side is comparatively dry, but two-thirds of the country trends toward the Atlantic and is well watered. The average annual rainfall of the whole country has been calculated to be about 48 inches. The central and eastern sections are generally regarded as best suited for stock raising. As nothing is known of hay making or curing fodder, generally speaking, stock is overfed during part of the year and starved during the remainder of the time.

One advantage of stock raising in Honduras is that there are no snows to cover the forage, interrupt growth, or make shelter necessary. Storms never cause the animals to drift from the range, but in the dry season when the valleys are parched the stock is sent into the mountains until the advent of the rainy season and new grass. The growth of the pasture is enhanced by burning off the dry grass during the summer months. This plan serves two purposes. In addition to improving the pasture, it destroys the cattle ticks harbored in the dry grass, but only temporarily, as the infested cattle are again turned in as soon as the new grass appears.

LIVE STOCK.

The cattle of the country are descended from the cattle imported from Spain soon after the conquest. Through inbreeding and neglect the original Spanish type is now degenerated, the cattle being small, thin fleshed, slow to reach maturity, and resemble somewhat the early type of Texas cattle, except that as the male animals are not castrated until 3 or 4 years of age they have short, heavy forehands, and short, thick necks, heads, and horns; in fact, are "stags" in appearance and quality. The cows more closely resemble the Texas cow. Stags or steers from 4 to 6 years old, grass fat, weigh from 900 to 1,100 pounds live weight, and the largest of them dress from 350 to 450 pounds of meat.

Little attention is paid to the management of cattle, the estimated annual increase being placed at from 12 to 15 per cent, the losses being attributed to the ravages of the cattle tick and the screw worm and the depredations of the leopard, puma, and wildcat.

A few cattle have been imported into Honduras from the United States, but not in sufficient numbers nor with the necessary persistence to produce any noticeable improvement in the native type. The sires imported originated mostly from above the southern fever area of the United States, and succumbed to southern fever infection soon after their arrival, leaving but little or no evidence of their introduction.

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There are few instances where any attempt has been made to improve the breeding of the live stock. From birth all animals are allowed to range unrestricted. Calves suckle their dams during a longer period under these conditions than is the custom in the United States, consequently cattle reach maturity at a late age as compared with those in other countries. As a rule heifers are 3 years old before they produce their first calf, and bulls are from 3 to 5 years old before they are considered fit for slaughter.

Around the small towns stock is permitted to roam at large and no attempt made to restrain the males after maturity. They mingle with the herds the year round. The result is that the offspring is mongrel in appearance and quality.

The hogs have large heads and small hindquarters and seldom attain more than 150 to 200 pounds live weight.

The horses are small, scrubby in appearance, have no particular gait, and show inbreeding.

According to report, large numbers of cattle have been exported from Honduras to Cuba. This trade was commenced in the year 1882 and continued until within a few years past, when it was suspended owing to the complete restocking of Cuba. A small cattle trade is being now carried on with Salvador, Guatemala, and British Honduras.

ANIMAL DISEASES.

The method followed for making inspections and obtaining information was to visit one or more ranches in each locality, inspect the cattle and other stock, and question the owners regarding the prevalence and nature of any diseases existing in the neighborhood. While little attention is paid to the ailments of live stock in Honduras, it is believed that all of the officials and other persons interviewed on the subject gave unreserved and truthful replies as far as their observations permitted. In addition to these inspections, casual inspections were made of hundreds of cattle encountered by the wayside while traveling from place to place.

It appears from information obtained from Honduran cattlemen, and from our own observations, that the ordinary cattle tick (garrapata)—the variety known as *Margaropus annulatus*—exists in and throughout Honduras, and that the losses sustained from the ravages of this pest, particularly during the dry season, are the most frequent and serious of all. There can be no doubt that Honduran cattle harbor in their blood the specific organism of southern fever, as otherwise a continued and profitable business extending over some years could not have been carried on by shipping nonimmune cattle to Cuba, where the infection of southern fever is also prevalent. The fact that the cattle shipped to Honduras from above the southern

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fever area of the United States seldom survive the change further indicates that the infection of southern fever is carried in the blood of the immune native cattle and is transmitted to the nonimmune imported cattle by the prevailing variety of tick.

Honduran cattle owners, while admitting that the tick causes severe losses, still maintain that the cattle tick of the country is noninfectious. This assertion is natural and pardonable, and may be readily understood when consideration is given the fact that the native cattle are immune and therefore seldom suffer from the acute form of the fever, while but few nonimmune cattle have been imported, the loss of these being ascribed to change of climate and forage.

The same ideas existed in Porto Rico a few years ago, where it required some heavy losses of nonimmune cattle to convince some stock owners that the apparently healthy Porto Rican cattle harbored in their blood the specific cause of southern fever, the same being transmitted by the tick in a more virulent and deadly form to a large percentage of the nonimmune imported cattle.

Actinomycosis is quite prevalent in the departments of Valle and Choluteca. According to native report it is locally attributed to the bite of a small green snake.

Toward the end of the rainy season, when vegetation is at its rankest growth, isolated cases of sore mouth (mycotic stomatitis) occur among cattle, the cause of which, according to popular belief, is due to the bite of a spider. This theory of the cause is probably as near the mark as the theory of the green snake bite being the cause of actinomycosis. The lesions of the tongue or mouth are treated by rubbing the abraded surfaces with salt and lemon juice.

Tuberculosis and contagious foot-and-mouth disease appear to be unknown.

Blackleg was found to be prevalent among calves in the departments of El Paraiso and Olancho.

In the department of Olancho it was stated that during the summer months, when animals drink from pools of stagnant surface water, cattle, horses, and mules sometimes drop dead without manifesting any previous symptoms of illness, and that other animals which subsequently graze over these lands likewise become affected and die, which facts would indicate the presence of the anthrax bacilli.

Foot rot is said to affect sheep and goats when they are grazed on wet lands.

Horses, mules, and asses appear to be singularly free from contagious diseases, as, while we saw hundreds of these animals, no case of glanders or farcy, nor of mycotic lymphangitis, was seen during our travels.

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Necrotic or gangrenous dermatitis seems to be quite common. In some instances it causes the hoof to drop off and in all cases proves to be a lingering, troublesome, and painful affliction. The natives ascribe the cause to the bite of a spider, the theory being that this particular insect seeks the hair of the fetlock for lining its nest and as the animal moves at feeling the loss of the hair the spider becomes enraged and bites the animal just above the hoof, thereby producing an inflammation that often results in the loss of the hoof and occasionally causes the death of the animal. Cattle as well as horses and mules are said to suffer severely from spider bites.

Cysticercus cellulosæ, or the bladderworm or tapeworm cyst of hogs, with its concomitant tapeworm, the *Tænia solium* in man, is quite prevalent in Honduras. The larval cysts observed in the flesh of infected hogs are there erroneously called trichinæ. The flesh of such animals is condemned.

DAIRY INDUSTRY.

Modern dairy methods as practiced in the United States are unknown in Honduras. Calves are allowed to suckle the cows during the entire lactation period. The usual custom is to milk the cows only once daily—in the morning—so that the milk may be delivered in time for the early breakfast of coffee and boiled milk. The native cow will not yield her milk down unless the calf has first been suckled and is tied close by. After milking, the calves are allowed to run with the cows during the day, but are separated from them at night. Under this system the average daily yield per cow does not exceed 2 to 3 quarts. No butter is made, the native butter, so called, being nothing more than sour cream. Some imported tinned butter is consumed in the larger towns.

Native cheese is considered an important and necessary article of diet. In Olancho a considerable quantity of cheese is made for sale and consumption in the capital. The method of manufacture is indeed primitive. The milk is curdled in troughs hewn out of large trees. The whey is drawn off and the curd salted and worked by hand. (Pl. XXV, fig. 1.) The curds are then placed into forms and submitted to pressure, the resultant product being nothing more than a dried compact mass of white curd.

POSSIBILITIES OF IMPROVEMENT OF LIVE STOCK.

The beef and dairy quality of the cattle may be easily improved by the exercise of modern management and by using purebred sires of the dairy or beef breeds. (See Pl. XXIII, fig. 2.) These animals should be obtained from within the southern-fever area of the United States, for the reason that cattle raised in this section are immune to

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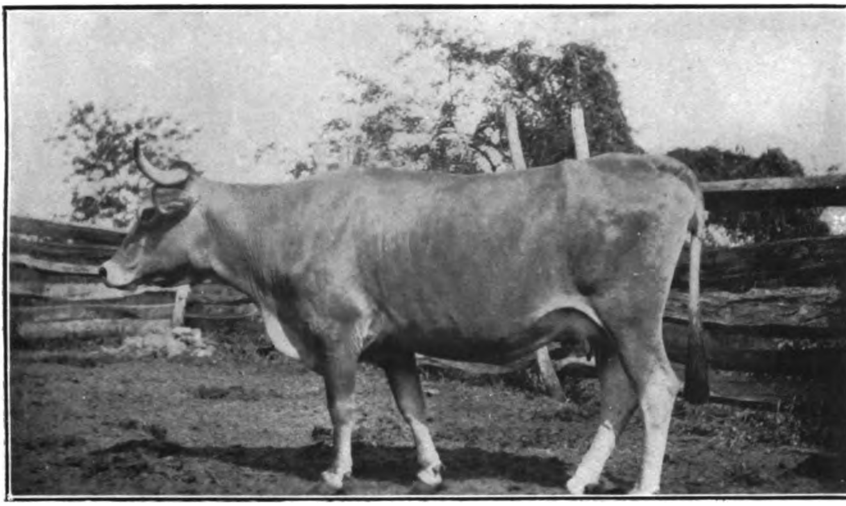

DAIRY CATTLE IN HONDURAS.

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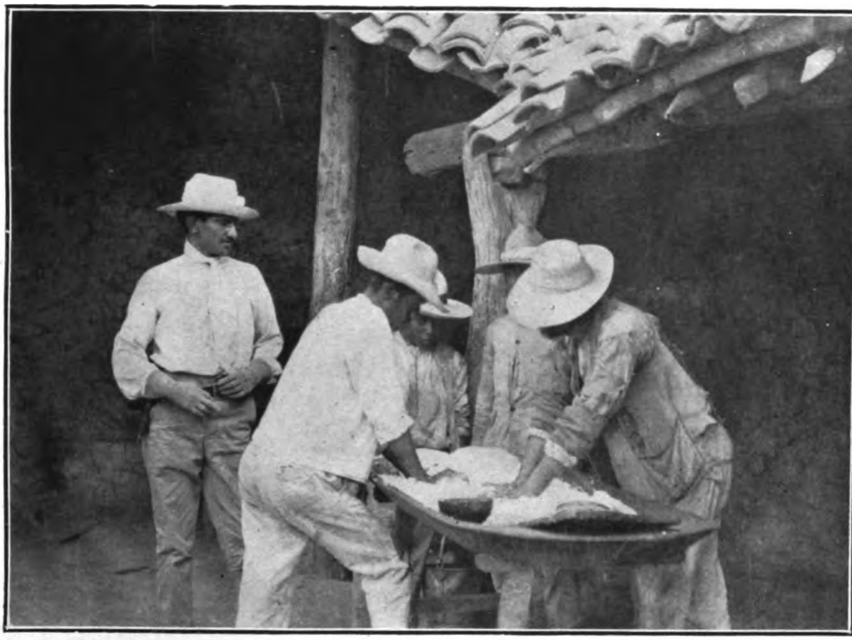

FIG. 1.—CHEESE MAKING IN HONDURAS. WORKING THE WHEY OUT OF THE CURD.

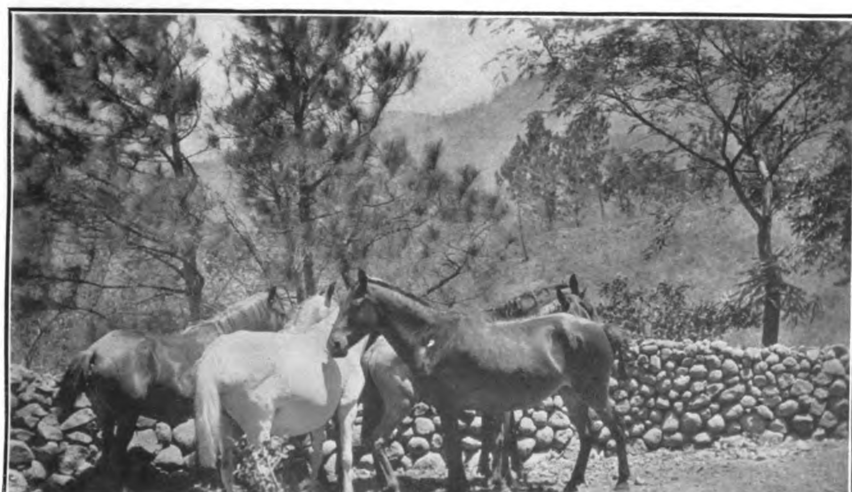

FIG. 2.—BEST TYPE OF HONDURAN HORSES.

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southern fever, the infection of which, as already stated, exists in and throughout Honduras.

The official estimates place the number of steers which could be exported per annum at 30,000; but given a near-by and stable market for surplus stock, the cattle industry of Honduras could be considerably increased, as a much larger area would then be planted into permanent guinea or para grass pasture.

The absence of an established market is a serious drawback to the live-stock industry of the country. The local consumption of meat is not large, and the methods of butchering are decidedly primitive and insanitary, with no facilities anywhere for preserving the meat by cold storage. The result of this situation is that fat cattle sell at a low price, sometimes as low as $10 gold per head, which offers no inducement to increase the size of the herds.

The native seldom raises more corn, beans, and rice than will keep his family from one crop to another. Corn for fattening cattle, sheep, or hogs is practically unheard of, for it is sometimes difficult to buy corn for human food in the capital of the country. The fact that all of the cattle are grass fed, coarse in appearance and quality, would classify them in the United States as "bologna stock."

Fattening cattle on bananas has demonstrated that waste fruit on a plantation can be turned to good account. Dr. Mitchell, United States consular agent at San Pedro, and Dr. Paz, an extensive cattle grower living north of San Pedro, have fattened cattle on bananas. Both declare that boiling the fruit in water improves it as a fattening medium, the action of the hot water expelling the tannic acid in the rind. Fed twice a day five hands (or clusters) each of green bananas, boiled, the animals made good gains. When the cattle were slaughtered the meat was found to be less firm than if the cattle had been finished on corn, but the result was an improvement over exclusive grass feeding. The stock relish the fruit either raw or boiled.

As tending to show the possibilities of feeding and fattening stock without grain, it was related that the natives living on the small islands or keys in the vicinity of Belize, British Honduras, fattened hogs on coconuts. On some of the larger keys cattle were fed on bananas and grass, and hogs on bananas and coconuts, the nuts being well broken up before feeding. No considerable number of animals were fed in this way; only enough for home consumption, with occasionally a few for market.

In the villages stock for meat is killed once a week. The carcass is hacked into shapeless chunks of haggled meat and bone, the meat being sold in two classes—with and without bone—the various divisions and separate cuts into which a carcass is divided in the United States being there unknown. Beef fat appears to be disliked by the

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Latin-American, therefore the external and other fat on the carcass is trimmed off and rendered into tallow.

At the capital there is a central market where meat is sold, all of which is slaughtered at 5 o'clock in the morning. The meat reaches the market a little after 6 o'clock, and as there is no delivery system the housewife carries the meat home, and it is frequently cooking in the consumer's pot by 8 o'clock.

The capital is situated in a beautiful valley surrounded by an amphitheater of mountains, and the nights are usually cool, so that the slaughtering could be done in the evening and the meat allowed to hang and cool during the night, but this would be a departure from long-established custom.

There is no smoked or salted meat to be had except a small quantity imported and consumed by foreign residents. Considerable "tasajo," or sun-dried meat (usually known to English-speaking people as "jerked beef"), is consumed by the country dweller. As it is difficult to cure or to keep fresh meat any length of time during the rainy season, the native prepares for this period by slaughtering his beef during the dry season and cutting the meat into strips and drying it on poles hung out of reach of animals and protected from insects. When the meat is dried hard the strips are stored away. Lard is rendered and put into bladders that are suspended from the rafters of the house, and some contrivance is placed over the top of the bladders to protect the contents from mice and rats.

According to official statistics, the number of cattle ranches in the country is given at 725 and the number of cattle owners at 621. The number of live stock in the country is reported to be as follows: Cattle, 466,215; horses, 64,434; mules, 13,434; asses, 2,373; sheep, 24,052; and hogs, 154,352.

Another drawback to the live-stock industry of the country is the lack of transportation facilities. There are no navigable rivers of any considerable length, and no railroads more than 50 miles long. From the central and eastern sections, where the best cattle districts are, there would be in some cases a drive of 150 miles to the ports on the northern coast. This in many instances would call for a progress not greater than 15 miles a day owing to the difficulty in traveling along trails through and over the mountains.

There are two ports on the northern coast having docks where stock could be loaded directly on the vessel, namely, La Ceiba and Puerto Cortes. There is only one port on the Pacific side; all freight in and out must be lightered from San Lorenzo on the mainland to the port of Amapala, situated on Tigre Island, a distance of 18 miles. There are no facilities for loading live stock at either of these places.

The steamships plying between the ports of the United States and Honduras are fruit steamers of Norwegian register. These

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steamers could be equipped for the carrying of live stock on the upper deck.

The absence of competent veterinarians in the country might be a serious matter in case of the outbreak of any epidemic diseases, as under the prevailing conditions the enforcement of a quarantine would be a difficult matter.

As nearly everybody in Honduras may have a few head of cattle, a widespread interest was evinced in the visit of the "commission," everyone expressing the hope that the ports of the United States might be opened to the importation of Honduran cattle, and thereby increase the purchasing and consuming capacity of the people and result in an enlarged and reciprocal trade between the two countries. However, as the disease of cattle known as southern fever, as well as the disseminator thereof, the cattle tick, exists in and is prevalent throughout Honduras, the importation of Honduran cattle can not be permitted because of the prohibitions of the law already quoted. Therefore, cattle which are infested with southern fever ticks, or which have been exposed to such infection within 60 days next before their exportation, are ineligible for importation into the United States.

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INCREASING CREAMERY PROFITS BY HANDLING SPECIAL PRODUCTS AND UTILIZING BY-PRODUCTS.

By S. C. Thompson,
In charge of Dairy Manufacturing Investigations, Dairy Division.

The creamery industry of this country is now developed to such an extent that in most dairy sections competition has become very keen, and creamery operators in order to be successful must use every means within their power to keep their operating expenses to a minimum and at the same time market their products to the best possible advantage.

Many creamery operators have had no special business training or experience, and very often ability along this line has not been considered essential to success, but with the close competition now existing the necessity for businesslike methods is becoming apparent. Opportunities for increasing the revenue of creameries are frequently overlooked and many wasteful practices are often permitted. Such results are partly due to the operator's lack of knowledge as to what might be accomplished, but largely because such creameries are not being pressed to the limit of their resources. However, the conditions are evidently improving, as recent reports show that many creamery managers now realize the importance of stopping the leaks often found in their operating methods and of putting their business on a more solid basis so as to better withstand the increasing competition and give their patrons better prices.

There are three methods that are being advantageously used for this purpose: First, by manufacturing some special products that will yield relatively large returns; second, by utilizing the by-products of the creamery to better advantage; and, third, by conducting some other line in connection with the creamery that will use spare power and labor and in this way reduce the operating expenses.

It is not the purpose of this article to describe in detail an outline that should be followed in all cases, nor is it intended to discuss the various subjects from a technical standpoint. It is written rather with the object of pointing out, along practical lines, opportunities for creameries to improve and increase their business that are frequently overlooked, and which if embraced would in many instances place them on a more successful basis.

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THE HANDLING OF SPECIAL PRODUCTS.

The special products most generally handled by creameries and perhaps the ones offering the best results are the sale of sweet cream and the manufacture of ice cream.

THE SALE OF SWEET CREAM.

In some sections of the country this means of disposing of a part or all of the product of the creamery has proved very satisfactory and profitable. It not only has enabled creameries to pay high prices for the sweet milk and cream delivered by their patrons, but has been a means of improving the quality of the product generally, and consequently has given a stimulus to dairying that might not have been possible otherwise. The demand for sweet cream from dealers who supply this commodity in bottles to consumers and from ice-cream manufacturers is rapidly increasing. Their supply is very often hard to get and frequently has to be shipped long distances. The prices paid creameries for this product usually range from 3 to 12 cents per pound of butterfat higher than can be obtained from its sale in the form of butter. On account of the demand for sweet cream and the prevailing high prices for the same many creameries conveniently located and having a supply of fresh, sweet material can therefore substantially increase their revenue above what would be possible if all their output was sold as butter.

The methods usually employed by creameries that ship sweet cream are as follows: The milk or cream received from the farm is carefully graded in the receiving room, and that portion intended for shipment as sweet cream is kept by itself during the entire process of preparing for market. If the whole milk is received it is at once run through separators and a cream secured having a definite amount of butterfat, which is usually guaranteed and made the basis of selling. If farm-separated cream is received which does not contain the required amount of butterfat, it is reseparated in order to bring it to the guaranteed standard. The standard frequently adopted when cream is shipped is a 40 per cent butterfat content, which gives a thick, heavy cream. This cream is carefully pasteurized, either by the "flash" or "holder" process. When the "flash" process is used the cream should be quickly heated to 165° F. or above and immediately cooled. With the "holder" process the cream should be heated to a temperature of 145° F. or more and held at that temperature from 20 to 30 minutes, either in a retarder specially designed for the purpose or in an ordinary covered vat, after which it should be quickly cooled.

Creameries have generally found the latter method more efficient, and for this reason it has been usually adopted where thorough work is necessary, although the "flash" process has been found satisfactory

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when reasonably high temperatures have been maintained. With either process of pasteurizing care should be taken to have the cream cooled quickly to a temperature as close to freezing as possible if the best results are to be secured.

From the cooler the cream is put into cans, usually holding 10 gallons, and shipped to market. In shipping it is protected from heat by the use of felt jackets or by wooden cases packed with crushed ice. If it is to be sold at retail it is bottled by the retailer and delivered to customers in the bottles, but when sold to bakeries or ice-cream manufacturers it is generally kept in the shipping cans until used. In both instances the cans are returned when empty to the creamery to be refilled.

Cans used for shipping sweet cream must be perfectly clean if a fine quality of cream is to be furnished. To secure such results they should be washed and steamed immediately after the cream has been removed from them and before any portion is allowed to dry or harden on the cans or become decomposed. After the cans have reached the creamery they should be rinsed and sterilized with live steam, then aired, drained, and cooled before being again used. If this work is carefully done no contamination of the cream is likely to come from the cans.

If care is exercised in selecting the raw material, and such material is properly pasteurized and cooled, it may be shipped for considerable distances, and with reasonable care will remain in good condition for a week or more. There is but little, if any, extra expense attached to the preparation of this product, and the prices received make its sale very desirable from the creamery standpoint; neither is there any doubt that many creameries can find a satisfactory market for such a product.

MANUFACTURE OF ICE CREAM.

During the past few years many creameries have installed machinery for making ice cream and have undertaken the manufacture of this product as a side line, with satisfactory results. The enormous increase in the consumption of ice cream, together with the fact that it is now generally on sale in the small towns as well as in the large ones, has opened new fields for its manufacture, thus giving the small operator an opportunity to do a successful business in competition with the larger ones.

Creamery managers should carefully study the opportunities for marketing this product, as the market and their ability to reach it are important factors in its successful manufacture. Creameries located in comparatively small towns can often find a local market for a sufficient amount of ice cream to warrant installing the machinery necessary for its manufacture on a small scale. In such cases

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the regular creamery force can do the work without extra expense. In the larger towns, or where there are opportunities for shipping large quantities, it would probably be necessary to establish a separate department with an experienced maker in charge. This, of course, would involve more capital and greater expense than is necessary in a small plant. In either event the market should be carefully considered, and if found satisfactory the business is likely to prove profitable.

Most States have laws requiring that ice cream shall contain a stated amount of butterfat known as the fat standard, and every creamery operator who contemplates engaging in the business should be familiar with these requirements and willing to meet them, for such standards aid the honest manufacturers by preventing unfair competition from the unscrupulous ones.

The creamery seems to be the logical place for manufacturing ice cream, as it has a supply of both raw cream and ice, which are the two most important factors in making this product. Therefore, with a suitable market creameries have a satisfactory combination for conducting such a business successfully. Then, again, they are in position to make just what quantity is necessary to supply the demand and use the remainder of their cream in the manufacture of butter, for which their market is already established. Consequently there is little risk of incurring the losses which sometimes happen in plants where ice-cream making is the special line.

The demand for ice cream depends to a large extent on the condition of the weather and the temperature of the atmosphere, and consequently is somewhat irregular; but in the creamery this fluctuation in the demand is less serious than where the outlet is for ice cream only. Reports from creameries making ice cream show that the prices received for this product are relatively high and that some of them are marketing a large portion of their output in this way. The average cost of making a gallon of ice cream in creameries is reported by them to be about 45 cents, and the same reports show the average wholesale selling price to be about 87 cents, leaving a margin of 42 cents per gallon.

The profits from the manufacture and sale of ice cream are clearly brought out by the following example: One hundred pounds of 18 per cent cream is equal to 12 gallons, which with a 66 per cent overrun will produce 20 gallons of ice cream, and if sold for 87 cents a gallon will amount to $17.40. Allowing that sugar and flavoring for this amount costs $1.40, there is left $16 for 18 pounds of butterfat used. On this basis the butterfat sells for 88.8 cents a pound. The same amount of butterfat made into butter with a 21 per cent overrun would produce 21.78 pounds of butter, and if sold for 31 cents a pound (average price for New York extras 1910) would amount

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to $6.75, or 37.5 cents a pound of butterfat. A comparison of these items shows a difference of 51.3 cents a pound in favor of ice cream.

The special equipment necessary for the average creamery to manufacture ice cream consists of freezer, ice crusher, holding cans, and hardening vat, and need not exceed $300 in cost. Such an outlay will often be paid for in one season and a substantial surplus remain from the profits of this branch of the business.

THE UTILIZATION OF BY-PRODUCTS.

But little attention has been paid to the methods of disposing of by-products in many creameries. So long as the buttermilk and skim milk have not accumulated so as to decay and cause offensive odors, operators have been content with little or no revenue therefrom. It has been the custom in many places to sell the buttermilk for a nominal price or even to give it away if removed sufficiently often to prevent it becoming a nuisance and causing contamination of the other creamery products. Occasionally large quantities have been regularly run into the sewer. Such methods are not only wasteful but needless, as there are several ways in which both skim milk and buttermilk may be utilized to bring large returns.

The methods of utilizing both skim milk and buttermilk most general and perhaps easiest to accomplish are feeding hogs at the creamery and manufacturing casein. There are, however, several varieties of soft cheese that may be made from skim milk, such as cottage, pot, or bakers'. These cheeses usually bring good prices, but as a rule are in limited demand; a few creameries, however, have been able to develop a market for all their skim milk in this way. Some creameries are also manufacturing cheese from buttermilk, but this being a comparatively new product, although a desirable one, is not yet in great demand.

FEEDING BUTTERMILK TO HOGS.

The value of buttermilk as a food for hogs has long been known to practical feeders and investigators, but notwithstanding this fact it has often been wasted in large quantities at creameries or has been sold by them for prices much below its value as a hog feed. With the growing interest in business methods has come a realization that such wasteful methods are unnecessary; consequently some creameries in various parts of the country are feeding their buttermilk to hogs and report good results. The value of buttermilk for this purpose depends largely on the price of pork, so that the present high prices give the buttermilk a relatively high value as a hog feed.

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SOME EXAMPLES OF PROFITABLE FEEDING.

On account of the limited experimental data available on this subject it is impossible to place a definite value upon buttermilk as a feed for hogs. The following, however, are some of the results reported by creameries in different States; and while the accuracy of these results can not be vouched for by the bureau, they show what has been done in a practical way by some creameries and indicate that under some circumstances creameries may find it profitable to feed buttermilk to hogs:

A creamery in California reports feeding 86 hogs on buttermilk and middlings, from which it realized an average net profit of $10.75 per hog for season.

A creamery in Iowa fed 308 hogs on buttermilk, corn, and pasture, and reports an average profit of $5.38 per hog.

A Kansas creamery reports feeding 78 hogs on buttermilk and corn, with an average profit of $2.59.

In Oklahoma one creamery fed buttermilk and shorts to 170 hogs and reports a net profit of $7.32 per head.

A Pennsylvania creamery reports feeding buttermilk, middlings, and shorts to 30 hogs, with an average profit of $6.66 per head.

A Washington creamery fed 69 hogs on buttermilk, shorts, and bran, with a profit of $5.26 per head.

These results, which are taken from the reports furnished by the creameries, show an average profit of $6.32 per hog. This amount includes the cost of labor in caring for the hogs and the value of the buttermilk fed for the season. It is, however, doubtful if there is any extra expense to the creamery for labor, as this work is usually done by the regular force and probably all the profit can be allowed on the value of the buttermilk fed.

The following table, made from the report of an Iowa creamery, shows the results obtained from feeding 12 hogs for 42 days and selling them on an 8-cent market:

Results of feeding 12 hogs for 42 days on buttermilk and corn.

	Price of hogs.	Weight of hogs.	Date.	Value of corn.	Profits from buttermilk.
		Pounds.			
Bought	$156.00	2,140	Oct. 27, 1910	$28.00	$43.20
Sold	227.20	2,840	Dec. 7, 1910		

The value of the buttermilk fed amounted to approximately $1 per day for the 12 hogs, or 8.33 cents each, and the average daily gain per hog was 1.38 pounds.

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The following extract from the report of a Michigan creamery shows some practical results from feeding buttermilk to hogs:

> Recently we turned off 11 pigs that were farrowed the 4th day of April, making their ages a few days over 5 months. Their combined weight (dressed) was 1,680 pounds. They were taken from the sow at 5 weeks old and in the meantime had become accustomed to and learned to drink buttermilk, so they lost no weight in getting started. They were given all the milk they would clean up, with no grain ration whatever, until they were about 2 months old. For the next 2 months they were fed a small ration of soaked corn once a day with the buttermilk. The amount was somewhat increased after that until turned off. Total and only kind of grain fed was 9 bushels of corn, soaked until it began to get sour or ferment.

Assuming the price of dressed pork to be 10 cents a pound, the receipts from the 11 pigs amounted to $168. After deducting for the nine bushels of corn at 65 cents a bushel, there is left $162.15, or a profit of $14.74 on each hog, no allowance being made for the value of the pigs at the time of weaning.

VARIOUS METHODS OF FEEDING IN VOGUE.

The methods of feeding and raising hogs at creameries vary considerably according to the location, the size of the creamery, and the interest taken in such work. Some operators desire to raise all the pigs they fatten, and before weaning time teach them to drink buttermilk that there may be no break in their thriftiness. This method also gives the pigs a larger capacity for assimilating this feed. Reports from creameries indicate that hogs having run on pasture until they weigh 150 pounds or more learn to drink buttermilk slowly, so they must be started carefully or there may be considerable loss; also that practically all creameries feed several times a day, from three to eight, beginning with small amounts, then increasing as the hogs become accustomed to the feed. They also report that sanitary conditions must be given careful attention and that the milk tank should be emptied and cleaned daily; the troughs and pens should be kept clean, and cinders or other substances should be used to prevent the pen from giving off bad odors and becoming too wet and soft. Plenty of good water, shade for summer, plank or cement feeding floor, and good bedding are to be found in the pens of must successful feeders.

Some feeders caution against the feeding of cold or stale buttermilk, stating that it causes constipation and piles and that it weakens the kidneys. Others report that skim milk when just turning sour causes bloating. Another precaution that should always be taken is to have all the skim milk and buttermilk intended for feeding purposes thoroughly pasteurized to prevent spreading the germs of tuberculosis. Where milk from several herds of cows is received at a creamery and the skim milk and buttermilk from the same is

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stored in a common receptacle the possibilities of it containing the germs of tuberculosis are very great. It has been demonstrated that hogs are very susceptible to this disease and that its prevalence among them is often due to the supply of milk. For these reasons the supply should always be pasteurized to prevent infection. Pens should be located at a sufficient distance from the creamery so that there will be no possibility of the odors reaching it to contaminate the products at any stage or process of manufacture. Unless both these precautions are taken it will be better to dispose of the by-products in some other way.

The advisability of feeding buttermilk to hogs depends entirely on local conditions at each creamery. There are several things to be considered in this connection, but where other means of disposal fail to give reasonable returns for the buttermilk and the creamery has sufficient and proper space for pens and the necessary means for properly feeding and caring for hogs, hog feeding should be a reasonably safe and sure method of disposing of by-products at a very satisfactory profit.

MANUFACTURE OF DRIED CASEIN.

Casein may be made from either skim milk or buttermilk, but the quality of casein from skim milk is superior to that made from buttermilk and consequently brings a much higher price. At the present time the price of dried casein from skim milk is relatively high, ranging from 8 to 10 cents a pound, and skim milk of average quality will yield from 3 to 3¼ per cent. At this price and yield skim milk would be worth from 25 to 30 cents per 100 pounds when made into this product. The manufacture of dried casein requires special machinery, such as vats, presses, grinding mills, heating coils, and drying chambers, and experienced operators are usually necessary to get best results. The special machinery and extra floor space required may prevent the small creamery from attempting its manufacture, but those creameries which handle large quantities of milk and have the required space may find it to their advantage to do so.

The process may be briefly stated as follows: The skim milk is run into a wooden vat, where it is heated to about 120° F. by steam being run directly into the milk. After the milk has reached this temperature commercial sulphuric acid is usually added to coagulate it. The acid and milk are thoroughly mixed by stirring. After the curd begins to form it is stirred gently until the whey becomes clear and the separation is complete. The whey is then drawn off and the curd allowed to remain in the vat and thoroughly drain. The curd is then inclosed in a heavy press cloth and put into a press in layers. The style of press used is similar to the old-style cider press, in which the curd remains until the next day, when it is broken up and run

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through the grinder, which grinds the chunks of curd into grains about the size of wheat. This fine curd is then spread on wire-cloth trays in very thin layers. Several trays are placed on a truck, one above the other, and wheeled into a drying chamber, where they remain for about 24 hours. The chamber is usully a tightly made box through which air heated by passing over steam coils is forced by a fan. The dried casein, after being removed from the drying chamber, is reground in a mill specially devised for the purpose and is then put into clean sacks holding from 100 to 125 pounds each, when it is ready for shipment to market.

Dried casein is used in the manufacture of certain kinds of cold-water paints, but the greatest demand comes from paper manufacturers, who use it in large quantities for paper sizing. The prices paid have steadily increased during the past few years and the demand has been good, thus affording a market for the entire output of a creamery at fair prices.

HANDLING EGGS THROUGH THE CREAMERY.[1]

There are several other lines that might be enumerated, but handling eggs and manufacturing ice seem to be the most satisfactory in connection with a creamery.

Handling eggs has been found an ideal side line for the creamery when properly regulated. The teams that bring milk and cream to the creamery can also bring eggs produced by patrons, with practically no extra expense. In this way the creamery can secure the eggs at frequent intervals and under such restrictions as will insure their being absolutely fresh and of finest quality. It can also cool the eggs if necessary and market them in a manner that will secure a premium above the quoted prices for the finest grades. Statistics show that under ordinary conditions of marketing there is a great loss on account of poor eggs. There is also much dissatisfaction from the consumer for the same reason, but where the producer is made responsible for the quality and the creamery, with its facilities for handling them properly, is made the central market the consumer finally gets a grade of eggs for which he is willing to pay a high price.

The plan that has proved most successful is for the creamery to deliver egg cartons and a private stamp to each patron. The eggs are stamped, placed in the cartons, sealed as soon as gathered, and kept cool until delivered.

In securing a market for guaranteed fresh eggs through a creamery, patrons are usually pledged to comply with certain rules, and in case

[1] This subject is more fully discussed in an article in the Twenty-sixth Annual Report of this bureau, entitled "Marketing Eggs Through the Creamery," by Rob R. Slocum. This article has also been published as Farmers' Bulletin 445.

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of failure to do so they are forbidden the privileges of the market. They usually agree to deliver eggs that are not over a specified number of days old and to gather them twice daily; to grade the eggs to secure uniform size; to keep white and brown eggs separate; to keep eggs clean and to store them in a cool, dry place; to stamp each egg and the carton in which they are placed; and not to sell eggs stamped with the creamery stamp to any other parties.

Prices received for eggs produced and marketed in this way usually range from 2 to 5 cents a dozen over the ruling price, and in some instances where special markets have been developed even greater premiums are secured. Doubtless many creameries can in this way improve their condition and secure closer cooperation with their patrons with little if any added expense.

MANUFACTURE OF ICE.

Proper refrigeration is of the greatest importance to every creamery, and in sections where natural ice is not produced it is a serious item of expense. A creamery that does not have facilities for properly controlling temperatures can not expect to make butter of satisfactory quality, therefore creameries without a natural ice supply must either buy ice or manufacture it. In most instances they can better afford to operate their own ice plant than to buy from others, and in this way make the manufacture of ice a practical side line. Refrigerating machinery is expensive, but when necessary in a creamery the manufacture and sale of ice will often result in using spare power and labor profitably.

Creamery operators will usually find one or more of the side lines described a desirable undertaking if satisfactory markets are obtained and reasonable care is exercised in manufacturing the products.

Quality is the most essential factor in the successful operation of a creamery, whether the product made be butter alone or in connection with one or more side lines. Relatively high prices can always be secured for butter and other creamery products of the finest quality, and when good quality and businesslike methods are combined a successful creamery is assured.

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THE TEMPERATURE OF PASTEURIZATION FOR BUTTER MAKING.

By L. A. Rogers, *Bacteriologist;* W. N. Berg, *Chemist;* and Brooke J. Davis, *Assistant, Dairy Division.*

INTRODUCTION.

The pasteurization of cream for butter making has for its primary object the elimination of the normal bacteria of the cream to enable the butter maker by controlling the ripening of the cream to secure a uniform product. Incidentally, it may remove some of the possible causes of the deterioration of the butter, as well as destroy the pathogenic bacteria and expel some of the gases and other volatile flavor-giving substances.

There is no fixed standard for the temperature of pasteurization in this country. In Denmark, where all cream used in butter making is pasteurized, a temperature of 82° to 85° C. (180° to 185° F.) is used, but in this country the cream is frequently heated to not more than 63° C. (145° F.), and rarely above 77° C. (170° F.).

It is obvious that it is desirable to determine the most effective temperature at which cream should be pasteurized for butter making. This temperature is the one at which the greatest number of undesirable factors are eliminated with the minimum effect on the cream itself. Several factors are involved in the determination of this temperature, among the most important of which are the uniform destruction of a large proportion of the bacteria of the cream; the destruction of the enzyms inherent in the milk; the avoidance of imparting scorched, metallic, or other undesirable flavors to the cream; and the possible increased loss of fat in the buttermilk.

This paper gives the results of an investigation which had for its object the determination of the proper temperature for the pasteurization of cream for butter making as indicated by the destruction of the bacteria and the enzyms and by the changes in flavor of the butter in storage.

METHOD OF HANDLING CREAM IN EXPERIMENTAL WORK.

The cream used came partly from milk separated at the creamery with which the field laboratory is connected and partly from hand separators. It was all sweet and of fair quality. The pasteurization was done in a continuous Jensen machine. The temperature was

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controlled by a hand valve and determined by a naked chemical thermometer inserted in the cream pipe near the machine. The variation was not over 1½° F., plus or minus. The cream was cooled at once to churning temperature and churned within three hours. This method was followed to avoid the complications due to poor starters, to contamination during ripening, or other factors which might change the flavor of the butter and obscure the influence of the pasteurization temperature. These results, therefore, throw no light on the effect of the growth of bacteria during the ripening of imperfectly pasteurized cream. Obviously, also, it does not necessarily follow that similar results would be obtained from cream which was sour or otherwise fermented at the time of pasteurization.

BACTERIOLOGICAL RESULTS OF PASTEURIZING CREAM.

The results for the first season's work are given in Table 1 and those obtained in the second season in Table 2. Bacteria were determined in composite samples of the pasteurized cream the first season, and in the second season the count of the raw cream was taken also. Lactose litmus gelatin was usually employed for plating, but in some cases lactose agar was used. The gelatin plates were incubated at 20° to 22° C. (68° to 72° F.) for five days and the agar plates at 30° C. (86° F.) for three days.

The lack of any established standard of bacteriological efficiency makes it difficult to draw conclusions from the bacteriological results alone. The number of bacteria remaining in the cream can not be taken as an absolute standard of the efficiency of the pasteurization, since this number varies not only with the temperature and time of pasteurization but also with the number and kinds of bacteria present in the cream before pasteurization. The percentage reduction is equally unreliable, as this also is largely dependent on the number of bacteria in the cream before pasteurization. A large number of bacteria in pasteurized cream may simply mean that the original cream contained a very great number of bacteria, or that a large proportion were heat resistant. If the number in the cream before pasteurization was very high, a large number may be left in the cream after pasteurization and the result still show a high percentage reduction. This is illustrated by the results obtained for sample 70 in Table 2, in which with nearly 1,000,000 bacteria remaining in the cream after pasteurization a reduction of 99.5 per cent was obtained. The influence of the kind of bacteria occurring in the cream is seen in a comparison of samples 54 and 70, both pasteurized at 82° C. (180° F.). In sample 54, 205,500,000 bacteria were reduced to 14,000, a reduction of 99.9 per cent, while with sample 70, 172,000,000 were reduced to 940,000, giving a reduction of 99.5 per cent. A large proportion of

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the bacteria in sample 54 were evidently in the vegetative stage and easily destroyed, while sample 70 contained many resistant spores.

The cream used in the first season's work was of good quality and about half of the results were obtained in September when the bacterial content was low. In the second season the proportion of hand-separator cream was greater and its inferior quality was indicated by the higher number of bacteria in the pasteurized cream. In Table 1 fairly uniform results are shown at 71° C. (160° F.) and above, and it is evident that 66° C. (150° F.) is too low to secure efficient pasteurization. The results given in Table 2 show efficient pasteurization at 77° C. (170° F.) and higher, and only fair results at 71° C. (160° F.).

It is evident from these results that with cream of good quality efficient pasteurization from the bacteriological standpoint can be secured by momentary heating to 71° C. (160° F.). This is, however, near the lower limit of safety, and if the bacterial content of the raw cream is high a temperature of 74° to 77° C. (165° to 170° F.) must be used to secure uniform results.

TABLE 1.—*Bacteria in cream after pasteurization—First season.*

No. of sample.	Pasteurizing temperature.		Bacteria per cubic centimeter.	No. of sample.	Pasteurizing temperature.		Bacteria per cubic centimeter.
	°C.	*°F.*	*Number.*		*°C.*	*°F.*	*Number.*
1	66	150	1,525,000	38	74	165	61,000
2	66	150	960,000	41	74	165	15,000
3	66	150	1,695,000	14	77	170	46,500
4	66	150	1,630,000	16	77	170	38,000
44	66	150	54,000	18	77	170	78,500
5	68	155	686,300	20	77	170	145,000
7	68	155	331,500	22	77	170	3[illegible],650
9	68	155	1,099,000	36	77	170	23,300
11	68	155	406,000	39	77	170	17,600
42	68	155	43,000	23	79	175	6,050
45	68	155	13,500	25	79	175	12,800
6	71	160	395,500	27	79	175	7,900
8	71	160	686,500	29	79	175	8,100
10	71	160	162,000	37	79	175	24,600
12	71	160	189,500	24	82	180	29,800
40	71	160	16,500	26	82	180	14,900
43	71	160	26,000	28	82	180	4,550
13	74	165	50,500	30	82	180	33,350
15	74	165	18,500	35	82	180	17,000
17	74	165	191,500	31	88	190	124,000
19	74	165	244,000	33	88	190	4,500
21	74	165	80,500				

AVERAGES OF TABLE 1.

Number of tests.	Pasteurizing temperature.		Bacteria per cubic centimeter.	Number of tests.	Pasteurizing temperature.		Bacteria per cubic centimeter.
	°C.	*°F.*	*Number.*		*°C.*	*°F.*	*Number.*
5	66	150	1,172,800	7	77	170	54,780
5	68	155	449,560	5	79	175	11,910
6	71	160	246,000	5	82	180	16,880
7	74	165	95,800	2	88	190	64,250

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TABLE 2.—*Bacteria in cream before and after pasteurization—Second season.*

No. of sample.	Pasteurizing temperature.		Per cubic centimeter in raw cream.	Bacteria per cubic centimeter in pasteurized cream.	Per cent reduction.	No. of sample.	Pasteurizing temperature.		Per cubic centimeter in raw cream.	Bacteria per cubic centimeter in pasteurized cream.	Per cent reduction.
	°*C.*	°*F.*	*Number.*	*Number.*	*Per cent.*		°*C.*	°*F.*	*Number.*	*Number.*	*Per cent.*
46	......	......	6,900,000	....	....	66	71	160	....	1,950,000	....
60	......	......	92,000,000	....	....	56	77	170	45,900,000	160,000	99.7
47	60	140	6,900,000	74,500	98.9	67	77	170	....	56,500	....
48	60	140	4,470,000	680,000	84.8	68	77	170	122,000,000	11,000	99.9
50	60	140	230,000,000	2,950,000	98.7	53	80	176	180,000,000	64,000	99.9
61	60	140	92,000,000	7,250,000	92.1	54	82	180	205,500,000	14,000	99.9
62	60	140	86,500,000	18,400,000	78.7	69	82	180	122,000,000	12,500	99.9
49	66	150	4,470,000	740,000	83.4	70	82	180	172,500,000	940,000	99.5
58	66	150	136,600,000	775,000	99.4	55	88	190	205,500,000	24,500	99.9
63	66	150	86,500,000	1,155,000	98.7	57	88	190	45,900,000	324,600	99.3
64	66	150	38,000,000	795,000	97.9	71	88	190	172,500,000	64,000	99.9
51	71	160	230,000,000	1,000,000	99.6	72	88	190	19,300,000	9,500	99.9
52	71	160	180,000,000	100,000	99.9	59	93	200	136,600,000	23,500	99.9
65	71	160	38,000,000	304,500	99.2	73	93	200	19,300,000	18,000	99.9

AVERAGES OF TABLE 2.

5	60	140	83,774,000	5,870,900	93.0	3	82	180	166,500,000	322,130	99.8
4	66	150	66,142,500	866,750	98.7	4	88	190	110,825,000	105,525	99.9
4	71	160	149,333,000	838,600	99.4	2	93	200	77,950,000	20,750	99.9
3	77	170	83,950,000	75,830	99.9						

TESTS FOR THE PRESENCE OF ENZYMS.

Certain enzyms occur normally in milk. When cream is churned these enzyms pass over into the butter. Their action is as yet undetermined, but it is possible that they take some part in the changes which occur in butter, even at the low temperatures of commercial storage. This possibility makes it desirable that they be destroyed in cream used for making butter.

The following definitions of the milk enzyms are taken for granted in this paper, no attempt being made to be rigorously exact from the biochemical point of view:

Peroxidase: An enzym that oxidizes other substances by transferring oxygen to them from some peroxid, such as hydrogen peroxid.

Catalase: An enzym that decomposes hydrogen peroxid, forming water and oxygen.

Galactase: The proteolytic enzym of milk.

Lipase: An enzym that splits fats (or fatty esters) into free fatty acids and the corresponding alcohols.

Although normal milk (or cream) probably contains no oxidase, this enzym was always looked for when testing for peroxidase. Up to the present time it has not been found in the materials tested. The naturally occurring oxidases are looked upon as mixtures of a peroxidase and a peroxid, or as mixtures of a peroxidase and a substance that can easily form peroxids.

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Enzyms are unstable substances or agents and are easily destroyed by high heat. For convenience, the temperature at which an enzym is destroyed is called its thermal death point, although an enzym being unorganized can not have a real death point. It should be remembered, however, that the temperature at which any particular enzym can be destroyed is somewhat indefinite, the enzym being gradually weakened by heat when the temperature approaches the death point or when the time of exposure is lengthened. Furthermore, the exact temperature at which it is destroyed varies with the conditions under which it is exposed to the heat. The reaction of the medium, the presence or absence of the substrate, the amount of moisture present, etc., may raise or lower the thermal death point.

During the summer of 1908 tests for peroxidase, catalase, and galactase were made on samples of cream. Formaldehyde solution (40 per cent) was added to the samples—1 or 2 liters of cream—in the proportion of 1 to 1,000. After the addition of the preservative portions of the sample were withdrawn for use and the remainder stored at room temperature. This method of preservation was found to be ineffective, since it did not prevent the growth of mold in many of the samples. Furthermore, the cream would not remain uniform in its composition in spite of repeated attempts to redistribute the fat by mixing. On account of the large amount of fat present chloroform in ordinary amounts could not be used. Although proper sampling at the end of the summer was impossible, the material was used to obtain approximate results for future guidance. In this paper are incorporated only those results of the tests for peroxidase and catalase which were made in the beginning of the summer. By suitable controls it was easily ascertained that the results of the tests were not appreciably affected by the preservative used.

During the summer of 1909 the tests for peroxidase and catalase were made on samples of cream obtained from the creamery soon after pasteurization.

For the work on galactase the buttermilk obtained after the churning of the different lots of cream was used. The samples of buttermilk were preserved at room temperature in stoppered bottles, 5 c. c. of chloroform being added to 1 liter of buttermilk. This concentration of chloroform has been found to have very little effect on the proteolytic enzym of milk.[1] Suitable bacterial counts showed that it preserved the buttermilk very efficiently. Toward the end of the summer tests for peroxidase and catalase were made on the samples of buttermilk to confirm the tests previously made on cream and to ascertain whether these enzyms were affected or destroyed during the changes that had meanwhile taken place. It was apparent from

[1] Harding, H. A., and Van Slyke, L. L. Chloroform as an aid in the study of m'' enzyms. New York Agricultural Experiment Station, Bulletin No. 6. Geneva, 1907.

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the qualitative tests for these enzyms that they were not yet very strongly affected (see pp. 313, 315).

The results for lipase were obtained in the early part of 1910 in the laboratories at Washington. Portions of the same sample of milk were pasteurized in a small apparatus specially constructed for the purpose, and the effect of the pasteurization on the activity of the lipase present was determined.

PEROXIDASE.

The method of testing for peroxidase was as follows: A small amount—5 to 10 c. c.—of cream (milk or buttermilk or curd solution) was transferred to a test tube. Two or three drops of a freshly prepared alcoholic solution (about 10 per cent) of gum guaiac were allowed to run down the side of the test tube so that the tincture remained on the upper surface of the liquid to be tested. The tube was allowed to stand 5 to 10 minutes. The nonappearance of color indicated the absence of oxidase. Two or three drops of a dilute solution of hydrogen peroxid (or old turpentine) were added, and if peroxidase was present a blue color developed where the reagents came in contact. Usually a blue ring on or near the upper surface of the liquid was formed.

Suitable controls were made to insure that the results would not be vitiated by variations in the degree of acidity of the cream, by the amount of preservatives used, or other factors. The peroxidase and catalase reactions were as strong in very sour raw cream or milk as in the original samples.

Results for peroxidase.—In Table 3 are summarized the results of the tests on the various samples of cream. Tests made on the corresponding samples of buttermilk when three months old gave practically identical results. From the table it is obvious that when cream was pasteurized under the conditions described on page 307 the peroxidase reaction was not obtained in cream pasteurized at 79° C. (175° F.) or above; at 77° C. (170° F.) it was generally absent, and in cream pasteurized at 74° C. (165° F.) or below positive tests were always obtained.

TABLE 3.—*Showing destruction of peroxidase and catalase in cream by pasteurization.*

Temperature of pasteurization.		Test for peroxidase.	Test for catalase.
°C.	*°F.*		
Raw.	*Raw.*	+	+
60	140	+	+
66	150	+	Weak.
68	155	+	....
71	160	+	Very weak.
74	165	+	–
77	170	±	–
79	175	–	–
82	180	–	–
88	190	–	–
93	200	–	–

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In general, these results are in accord with those obtained by other investigators who pasteurized for comparatively short periods of time. It must be borne in mind, however, that the death temperature of an enzym is so strongly influenced by so many conditions that an exact agreement between the above results and those obtained by other investigators can hardly be expected. Thus, Herholz[1] found that milk heated one minute at 75° C. (167° F.) gave an uncertain test with guaiac for peroxidase. Hippius[2] obtained the same result with milk heated in exactly the same way. Wilkinson and Peters[3] found that at 78° C. (172° F.) the guaiac test for peroxidase became negative. They do not say how long the milk was maintained at that temperature.

The question of how long the peroxidase can exist in butter under ordinary conditions of storage is important, since the peroxidase present in butter, in spite of the absence of a peroxid, may be able to transfer slowly some of the inclosed oxygen to the several oxidizable substances present. It is possible that such slow oxidation may be materially assisted by the presence of organic salts of iron or of other metals and by the fine subdivision of the inclosed oxygen by overworking the butter.[4]

The tests for peroxidase in buttermilk were repeated in June, 1910, when the samples were one year old. The reaction was given by only about half the samples that had previously given it, clearly indicating the instability of the peroxidase. The disappearance was probably brought about by the slow digestion that had taken place. The peroxidase reaction in raw milk can be made to disappear in about 20 or 25 days, by allowing the milk to sour, adding chloroform to eliminate subsequent bacterial action, and then allowing proteolysis by the lactic acid to go on, either with or without the aid of pepsin.

Peroxidase in raw-cream butter can be detected as follows: Melt the sample at about 45° C. (113° F.), let the curd solution settle to the bottom of the beaker, pour off the clear supernatant fat, and use 5 to 10 c. c. of the curd solution for the test with guaiac, as usual. All the samples thus tested (five, fresh) gave positive reactions, although the reaction appeared to be weak when compared with the same reaction in raw cream.

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[1] Herholz. Beiträge zu bisher bekannten Reaktionen zur Unterscheidung von roher und erhitzter Milch mit besonderer Berücksichtigung der Guajakproben. Dissertation. P. 70, Table C. Braunsberg, 1908.

[2] Hippius, Alexander. Biologisches zur Milchpasteurisierung. Jahrbuch für Kinderheilkunde, Band 61, p. 375. Berlin, 1905.

[3] Wilkinson, W. Percy, and Peters, Ernst R. C. Eine neue Reaktion zur Unterscheidung von roher und erhitzter Milch sowie zum Nachweise von Wasserstoffsuperoxyd in der Milch. Zeitschrift für Untersuchungen der Nahrungs- und Genussmittel. Band 16, Heft 3, pp. 172–174. Berlin, 1908.

[4] Rogers, Lore A. Fishy flavor in butter. U. S. Department of Agriculture, Bureau of Animal Industry, Circular 146, p. 12. Washington, 1909.

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Five samples of butter that had been in cold storage for periods ranging from 1½ to 4½ years were tested for peroxidase. They were contained in ordinary tin cans, and only the inner portions of the samples were used because of the presence of iron rust on that part of the sample in contact with the can. All of these gave such unusually strong peroxidase reactions with tincture of guaiac and hydrogen peroxid as to suggest an unusual cause. In marked contrast to raw cream, these curd solutions obtained from old butter when boiled and cooled still gave the peroxidase reaction. Even repeated boiling and cooling did not remove from this material the property of giving this reaction. Evidently the peroxidase in raw cream is different from that present in these samples of old butter.

In view of the fact that the catalytic oxidation of guaiac resin and of other substances by metals or their salts has frequently been observed,[1] it was natural to suppose that the peroxidase reaction in the boiled curd solutions was due not to the enzym occurring normally in raw milk, but to some metallic compound of extraneous origin. The old-curd solutions were qualitatively tested for iron by adding to the unconcentrated material a few drops of dilute hydrochloric acid and potassium ferrocyanid or ammonium sulphocyanate. Positive tests were easily obtained. Control tests showed that much more iron was present in the curd solutions than in milk. Raw milk or buttermilk containing approximately 0.1 per cent of iron added as chlorid or sulphate will give the peroxidase reaction even after being boiled. It would seem reasonable to attribute the peroxidase reaction in the boiled curd solutions to their iron content.

Observations such as these may be of value in explaining the detrimental influence of rusty milk cans, etc., on the flavor and keeping quality of butter.[2]

CATALASE.

The method of testing for catalase was as follows: Fifty cubic centimeters of cream, milk, or buttermilk was introduced into a 100 c. c. Erlenmeyer flask and 25 c. c. of commercial hydrogen peroxid solution added. The flask was quickly closed with a rubber stopper provided with a bent glass tube, the other end of which was inserted into a fermentation tube (capacity 20 c. c.) filled with water. If raw cream were used, the oxygen liberated by the catalase rose in the fermentation tube and completely filled it three or four times in a few minutes. With raw milk or pasteurized cream the liberation

[1] Alsberg, Carl A. Beiträge zur Kenntnis der Guajak-Reaktion. Archiv für Experimentelle Pathologie und Pharmakologie. Supplementband 1908. Festschrift Prof. Oswald Schmiedeberg, pp. 39–53. Leipzig, 1908.

Colwell, Hector C. The catalytic oxidation of guaiac resin by metallic copper. Journal of Physiology, vol. 39, pp. 358–360. London, 1909–1910.

[2] Olson, George A. Rusty cans and their effect upon milk for cheesemaking. Wisconsin Agricultural Experiment Station, Bulletin 162. Madison, 1908.

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of gas was slower, until with cream pasteurized at high temperature only a few bubbles were obtained even on long standing. By this method the distinction between raw cream and that in which catalase has been destroyed was easy to make. The above proportions of cream and hydrogen peroxid were used because they were found to be convenient; slight deviations from them do not detrimentally affect the results.

Results for catalase.—From the results (obtained in June, 1909) summarized in Table 3, it is apparent that the catalase in cream was destroyed when pasteurized at 70° to 71° C. (158° to 160° F.). This is a few degrees below the temperature at which peroxidase is destroyed. Confirmatory tests made in September, 1909, on the corresponding samples of buttermilk gave similar results. The tests on buttermilk were repeated in June, 1910. None of the samples then gave the catalase reaction except No. 59, from cream pasteurized at 93° C. (200° F.), which gave it strongly. Accidental bacterial contamination was the probable cause. It did not give the peroxidase reaction, showing that in this instance, at least, the two reactions are due to two different substances or agents. This has been observed before.[1]

Catalase in appreciable amounts probably is not present in butter made from properly pasteurized cream. As a possible factor influencing the quality of storage butter it may obviously be left out of consideration when butter is made from pasteurized cream. A discussion of its possible action in raw-cream butter must be deferred until more data are obtained.

GALACTASE.

METHOD OF MEASURING THE ACTIVITY OF GALACTASE IN BUTTERMILK.

To determine whether the galactase in cream was destroyed or partly inactivated at the different pasteurizing temperatures, water-soluble nitrogen was determined in the buttermilk shortly after churning and after preservation (with chloroform) for an average of 83 days at room temperature.

Into a 500 c. c. volumetric flask 50 to 200 c. c. of buttermilk was introduced. The same volume of buttermilk was used at the beginning and at the end of the period. Distilled water was added up to about 400 to 450 c. c. One-fifth normal acetic acid was slowly and carefully added until the casein separated completely in large flocculi, leaving the supernatant liquid practically water clear. For amounts of acetic acid used see Table 5. Distilled water was added to the 500 c. c. mark, and the mixture was filtered on a 32 cm. folded filter (S. & S. No. 588 or 595) into a clean, dry 500 c. c. volumetric

[1] Kastle, J. H. The oxidases and other oxygen-catalysts concerned in biological oxidations. U. S. Treasury Department, Public Health and Marine-Hospital Service, Hygienic Laboratory, Bulletin 59. Washington, 1910.

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flask. During the filtration the funnel was covered with a well-fitting watch glass to minimize evaporation. The first part of the filtrate was returned to the filter two or three times until the filtrate was freed from all particles of suspended protein. When 200 c. c. of buttermilk were used the filtrate was colored faintly yellow and was not more opalescent than other solutions of equal protein content. In two 200 c. c. portions of the filtrate total nitrogen was determined by the usual Kjeldahl method. The remaining part of the filtrate was measured and the total amount recovered noted. The figures were recorded to make certain that the amount of filtrate recovered did not vary enough to affect the results appreciably. Variations in the amount of filtrate evaporated will introduce little or no error into the calculations, if the same amounts of buttermilk are used at the beginning and the end of the period. The average amount of filtrate recovered was 465 c. c.; both in June and in September, 1909, it varied between 445 and 490 c. c. Some of the filtrate was of course retained by the precipitate on the filter paper.

With a little practice the amount of acetic acid to be used in effecting the complete precipitation of the casein can be accurately determined by noting the appearance of the precipitate and of the liquid in which it is suspended. The precipitation is very nearly maximal when the casein separates out in large flocculi that are suspended in a practically water-clear fluid. This is easily observable at the line of contact between the upper surface of the liquid and the side of the containing vessel. When the precipitation is properly made filtration is rapid, requiring usually from two to four hours. It was frequently found convenient to allow filtration to go on overnight. The funnel is then lowered so as to close almost competely the receiving flask. From time to time the filtrates were tested by the addition of more acid or of alkali to make certain that the amounts of acetic acid used were such as to give the maximal precipitation. No difficulty was experienced in correctly judging these amounts.

The number of possible sources of error in this determination is large, and care must be taken to maintain uniform conditions when making these determinations at the beginning and the end of the period.

The average of the two nitrogen determinations was multiplied by $\frac{5}{2}$, as 200 out of 500 c. c. was used, and the result was called (total) water-soluble nitrogen. Obviously this is not absolutely correct, because the volume of the filtrate is 500 c. c. minus the volume of the precipitate. The figures for the increase in water-soluble nitrogen (Table 4) were obtained by subtracting the amounts obtained in June from those obtained in the same way in September.

Results for galactase.—In all of the samples of buttermilk tested water-soluble nitrogen increased very appreciably. The increase was

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greatest in the buttermilk from raw cream and least in the buttermilk from cream pasteurized at 93° C. (200° F.). Between 71° and 77° C. (160 and 170° F.) this increase was markedly diminished, indicating that pasteurization between these temperatures strongly inhibited the activity of the galactase. The proteolytic agent, presumably galactase, was not completely destroyed by the pasteurization at any of the temperatures used.

As the pasteurizing temperature was raised the amount of water-soluble nitrogen in the fresh samples was appreciably diminished. All of the filtrates contained protein coagulable by heat in neutral solution, so that the diminished content of water-soluble nitrogen may be due, therefore, to a partial, but not complete, coagulation of milk proteins other than casein.

TABLE 4.—*Influence of pasteurization on the activity of galactase in buttermilk.*

Cream.			Water-soluble nitrogen in 100 c. c. of buttermilk expressed as—								
Sample No.	Pasteurized at—		Cubic centimeters of N/5 nitrogen.			Grams of nitrogen.			Per cent of total nitrogen.		
			June.	Sept.	Increase.	June.	Sept.	Increase.	June.	Sept.	Increase.
	°C.	*°F.*	*c. c.*	*c. c.*	*c. c.*	*Gram.*	*Gram.*	*Gram.*	*Per cent.*	*Per cent.*	*Per cent.*
46....	Raw.	Raw.	41.8	99.5	57.7	0.117	0.279	0.162	25.3	60.3	35.0
47....	60	140	40.8	90.3	49.5	.114	.253	.139	24.7	54.8	30.1
48....	60	140	35.7	81.3	45.6	.100	.228	.128	21.7	49.3	27.6
58....	66	150	37.5	82.1	44.6	.105	.230	.125	22.7	49.8	27.1
63....	66	150	36.9	80.2	43.3	.103	.225	.122	22.4	48.6	26.2
52....	71	160	33.4	87.8	54.4	.094	.246	.152	20.3	53.3	33.0
51....	71	160	35.7	85.4	49.7	.100	.239	.139	21.7	51.8	30.1
56....	77	170	28.6	59.2	30.6	.080	.166	.086	17.3	35.9	18.6
53....	80	176	33.4	66.6	33.2	.094	.187	.093	20.3	40.4	20.1
54....	82	180	28.0	58.6	30.6	.078	.164	.086	17.0	35.5	18.5
55....	88	190	23.6	42.0	18.4	.066	.118	.052	14.3	25.5	11.2
57....	88	190	27.4	51.5	24.1	.077	.144	.067	16.6	31.2	14.6
59....	93	200	24.0	42.5	18.5	.067	.119	.052	14.6	25.8	11.2

Total nitrogen in 100 c. c. buttermilk=0.462 gram.

TABLE 5.—*Analytic data obtained in Table 4 calculated to average digestion period.*

Cream.			Increase in water-soluble nitrogen in 100 c. c. of buttermilk calculated to 83 days digestion period, expressed as—			Digestion period.	Volume of buttermilk used.	Volume of N/5 acetic acid used for precipitation.	
Sample No.	Pasteurized at—		C. c. of N/5 nitrogen.	Grams of nitrogen.	Per cent of total nitrogen.			June.	Sept.
	°C.	*°F.*	*c. c.*	*Gram.*	*Per cent.*	*Days.*	*c. c.*	*c. c.*	*c. c.*
46	Raw.	Raw.	56.3	0.158	34.2	85	50	15	9
47	60	140	48.3	.136	29.4	85	50	13	9
48	60	140	45.1	.126	27.3	84	100	27	20
58	66	150	45.1	.127	27.4	82	200	44	17
63	66	150	44.9	.126	27.2	80	200	41	17
52	71	160	50.2	.140	30.4	90	150	41	14
51	71	160	45.3	.127	27.5	91	150	34	13
56	77	170	31.7	.089	19.3	80	200	44	20
53	80	176	33.2	.093	20.1	83	150	40	21
54	82	180	31.4	.088	19.0	81	200	44	20
55	88	190	18.9	.053	11.4	81	200	44	17
57	88	190	25.0	.070	15.2	80	200	44	28
59	93	200	18.7	.052	11.4	82	200	39	17

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According to Babcock, Russell, and Vivian[1] "it is apparent that heating the enzym solutions for 10 minutes at 76° C. suffices to destroy the digestive ferment galactase, and even at 71° C. for the same exposure its action was materially reduced." Hippius[2] found that the proteolytic enzym of cow's milk can withstand an exposure to 65° C. (149° F.) for one-half hour and is not destroyed till near 100° C. (212° F.), at which temperature a short exposure is sufficient. In the light of such results it does not seem remarkable, therefore, that cream pasteurized at 93° C. (200° F.) for about 30 seconds should still contain active galactase. It is of course possible that in pasteurized milk or buttermilk that has been preserved for long periods of time the observed proteolysis is due not alone to undestroyed galactase, but to the hydrolytic action of water as well.

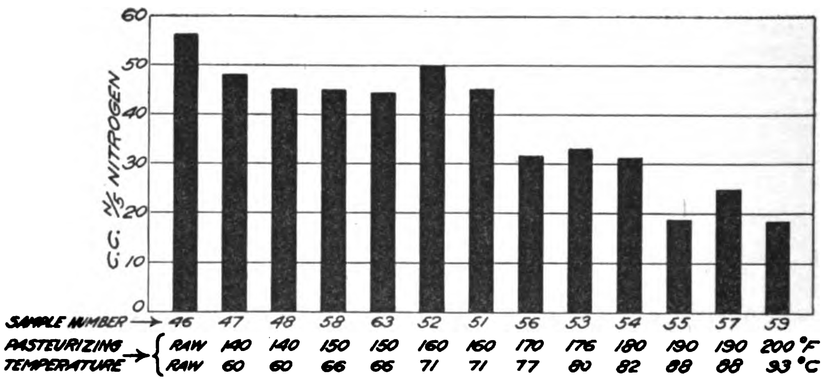

FIG. 24.—Increase in water-soluble nitrogen in 100 c. c. of buttermilk, calculated to 83 days digestion period. (Graphic representation of analytical data in Table 5.)

LIPASE.

Portions of the same sample of raw milk were pasteurized at different temperatures and the activity of the lipase present determined by titrating the amount of acid liberated by it from ethyl butyrate. The apparatus in which the pasteurization was done consisted of a 2½-liter acid bottle containing the milk to be pasteurized. This was inverted over a 5-inch funnel connected by means of rubber and glass tubing with a coil of glass tubing (obtained from two vertical condensers) immersed in a pan containing hot water. From the coil the milk was passed through two ordinary Liebig condensers.

About 3 liters of cold raw milk as received from the dealer was transferred to two large beakers and heated in a hot-air bath to 40°

[1] Babcock, S. M., Russell, H. L., and Vivian, Alfred. Properties of galactase: A digestive ferment of milk. Wisconsin Agricultural Experiment Station, Fifteenth Annual Report, 1898, p. 82.

[2] Hippius, Alexander. Biologisches zur Milchpasteurisierung. Jahrbuch für Kinderheilkunde, Band 61, p. 380. Berlin, 1905.

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to 45° C. (104° to 113° F.), requiring 20 to 40 minutes. The milk was transferred to a 2½-liter bottle and inverted over the funnel connected with the pasteurizer. The water in the pan having been previously heated to 90° to 93° C. (194° to 200° F.), the milk was allowed to flow through the glass coil in which the pasteurization took place. The temperature of the milk as it left the coil was indicated by a thermometer placed in it for the purpose. When the milk entering the coil was at 45° C. (113° F.) and the water in the pan at 93° C. (200° F.) the outflowing milk was at 82° C. (180° F.). The burner under the pan was lowered or turned out, according to circumstances, and as the temperature fell the receivers (300 c. c. flasks) at the end of the condenser were changed so as to receive in each one of them the milk that had been pasteurized over a range of temperature not exceeding 2° C. (3.6° F.). In some of the experiments the range was but 1° C. (1.8° F.). The amount of milk received in each flask varied from 150 to 250 c. c. When the pasteurizing temperature was highest the milk as it left the condenser was at 45° C. (113° F.). The receivers were placed in ice and salt for a few minutes to cool the milk still further.

The height of the 2½-liter containing bottle above the coil, etc. (approximately 60 cm.), was so adjusted that the milk passed through the apparatus in about the same time as it does in the "flash" pasteurizer, i. e., 15 to 30 seconds. The pasteurization of 3 liters of milk and its collection in 9 or 10 separate receivers, with the rejection of milk pasteurized at intermediate temperatures, was accomplished without difficulty in 13 to 14 minutes. In general, the pasteurization was conducted as closely as possible under the same conditions as existed in the creamery at the field laboratory. The several series of samples of pasteurized milk were tested for the peroxidase reaction, using tincture of guaiac and dilute hydrogen peroxid solution. The peroxidase reaction disappeared at 77° to 79° C. (170° to 174° F.), indicating that in this respect at least the pasteurization in the two places had been carried out in substantially the same way.

METHOD OF MEASURING THE ACTIVITY OF LIPASE IN MILK.

Into each of two 100 c. c. Erlenmeyer flasks a 50 c. c. portion of the sample was transferred from a measuring cylinder, beginning with the sample that has been pasteurized at the highest temperature. One-half of a cubic centimeter of chloroform and 5 drops of phenolphthalein solution were added to all the flasks. To one of each pair of flasks 0.5 c. c. of ethyl butyrate was added, the other, containing the milk, chloroform, and phenolphthalein mixture, being used as a control. The contents of all the flasks were immediately titrated to a distinct and uniform pink with tenth normal sodium hydroxid, after which the flasks were tightly stoppered with rubber

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stoppers. This titration gave the amounts of alkali required to neutralize the acidity of the milk, ethyl butyrate, etc. The flasks were set aside (a thermostat at 26° C. [79° F.] was convenient for this purpose) and rotated about once in 12 hours. At 24-hour intervals the liberated acid was titrated, both in the ethyl butyrate mixtures and in the controls, to a distinct and uniform pink, the color from the previous day's titration having been discharged by the acid liberated. In titrating the controls at the beginning of an experiment approximately 11 c. c. of tenth normal sodium hydrate was required to bring the mixture of milk and chloroform to a reaction faintly alkaline to phenolphthalein. By the following day the pink color had disappeared, and the reaction could again be made alkaline by the addition of approximately 1 c. c. of tenth normal sodium hydroxid. In this way it was ascertained that in 24 hours about 1 c. c. of alkali was in some way consumed, probably by slow combination with some constituent of the mixture. If more than 1 c. c. of alkali was added, the pink color persisted for a longer time; thus, after the addition of an excess of 3 c. c. of alkali, the control remained pink for over 8 days. In mixtures containing milk pasteurized at 74° C. (165° F.) or over (and presumably no lipase) and ethyl butyrate, chloroform, etc., the pink color disappeared more rapidly, which indicated that, in addition to the alkali consumed as described above, a small amount of alkali was used up in hydrolyzing ethyl butyrate.

The figures in the last column of Table 6, headed "Corrected total acid," are the figures in the preceding column minus 6.6 c. c., which represents very closely the amount of alkali consumed in the two above-described ways; i. e., the correction used here represents the amount of alkali consumed in those mixtures in which the lipase was apparently destroyed, and which also contained ethyl butyrate.

Results for lipase.—The figures in Table 6 are typical of three other series giving similar results. It is evident that the lipase was destroyed very near 70° C. (158° F.). It is possible that it was not totally destroyed until a few degrees above this temperature, but the method did not permit the distinction between the very slow hydrolysis of ethyl butyrate by the small amounts of alkali present or by the weakened lipase possibly present in the milk pasteurized above 70° C. (158° F.). An attempt to strengthen the lipase by the addition of an excess of alkali showed this to be inadvisable, because the excess of alkali tended to hydrolyze the ethyl butyrate directly.

The destruction of lipase at somewhat lower temperatures was observed by Terroine,[1] who found that pancreatic juice lost its lipolytic power when heated for 10 minutes at 65° C. (149° F.), and by

[1] Terroine, Emile F. Zur Kenntnis der Fettspaltung durch Pankreassaft. I. Biochemische Zeitschrift, Band 23, p. 424. Berlin, 1910.

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Hippius,[1] who found that the lipase in human milk was destroyed when exposed for a short time to a temperature of 64° C. (147° F.)

TABLE 6.—*Influence of pasteurization on the activity of lipase in milk.*

Milk pasteurized at—		N/10 sodium hydroxid required for neutralization of milk, etc.	N/10 acid liberated at end of—					Total acid liberated.	Corrected total acid.
			1 day.	2 days.	3 days.	4 days.	7 days.		
°*C.*	°*F.*	*c. c.*	*c. c.*	*c. c.*	*c. c.*	*c. c.*	*c. c.*	*c. c. N/10.*	*c. c. N/10.*
Raw.	Raw.	12.9	10.2	6.2	4.3	3.0	3.3	27.0	20.4
55	131	12.3	7.8	5.1	3.8	2.8	3.5	23.0	16.4
57	135	12.5	7.7	5.2	4.0	2.5	3.6	23.0	16.4
60	140	12.3	7.6	5.0	3.4	2.5	3.4	21.9	15.3
63	145	12.6	6.3	3.9	3.0	2.1	2.8	18.1	11.5
66	150	12.4	3.7	2.8	2.0	1.7	2.2	12.4	5.8
68	155	12.4	2.5	1.9	1.5	1.3	1.9	9.1	2.5
70	158	12.3	2.2	1.6	1.2	1.2	1.9	8.1	1.5
74	165	12.4	1.7	1.2	1.1	1.2	1.7	6.9	0.3
77	170	12.4	1.9	1.2	1.1	1.1	1.6	6.9	0.3
80	176	13.1	1.6	1.0	1.3	1.0	1.7	6.6	0.0

DISCUSSION OF ENZYM EXPERIMENTS.

In general, the results obtained on the thermal death points of the milk enzyms are in accord with those obtained by other investigators. But close comparisons with their work could not always be made, because the pasteurization process was seldom carried out by two investigators in exactly the same way or for the same length of time. Frequently their descriptions were so imperfect in detail as to make a reproduction of their work, were it desired, practically impossible. For example, one investigator omitted to state how long the pasteurization lasted. In addition, variations in the methods of testing for these enzyms make comparisons still more difficult.

It has been shown that in the pasteurization process catalase and lipase are destroyed at 70° to 71° C. (158° to 160° F.); peroxidase was destroyed at 77° to 79° C. (170° to 175° F.); and galactase, though strongly inactivated between 71° and 77° C. (160° and 170° F.), is not totally destroyed even at 93° C. (200° F.).

It is highly probable that under the pasteurizing conditions prevailing at most creameries that use pasteurized cream for butter making the first two of these enzyms are destroyed. Therefore, as possible factors influencing the keeping qualities of butter made from pasteurized cream, these may be left out of consideration. But on account of their higher thermal death points it is probable that peroxidase is not always destroyed and galactase is rarely, if ever, completely destroyed. Consequently both of these enzyms may be considered possible factors in the deterioration of storage butter.

[1] Hippius, Alexander. Biologisches zur Milchpasteurisierung. Jahrbuch für Kinderheilkunde, Band 61, p. 377. Berlin, 1905.

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It has been shown that both of these enzyms are present in buttermilk obtained from cream pasteurized at high temperatures. Researches are now in progress to determine whether the peroxidase is engaged in slowly oxidizing one or more of the constituents of the butter or in assisting in such oxidation. The figures in Table 4 show that the galactase remaining undestroyed in the buttermilk continued to hydrolyze the proteins present. The possible activity of galactase in storage butter is likewise being studied.

It is obvious that a similar study of the action of the other two enzyms would be of interest because of their possible influence on the keeping quality of raw-cream butter.

It must not be inferred that the writers assume a relation between the milk enzyms present in butter and its keeping qualities. The results thus far obtained, however, indicate that the probability of the existence of such a relation is great enough to warrant the studies already undertaken along these lines. The present paper, on the chemical side, is therefore preliminary only.

SCORING THE BUTTER.[1]

The butter made in these experiments was packed in hermetically sealed cans holding about 2 pounds each and stored at —12° C. (10° F.). For scoring, one can was sent to each of three experienced butter judges who worked independently of each other and with no knowledge of the history of the sample. The scores for the first season's work were so inconclusive that they are not included in the tables. In the second season's work a wider range of temperature was used, exceeding the limits of safety at both ends of the range. The first scoring was made after about 40 days in storage, and the second after about 150 days.

The scores are given in Table 7, and presented graphically in figures 25 and 26. The scores of the three judges are not averaged because, while in the main they agree closely, it is believed that on account of varying standards an average will not always indicate the true conditions. The average score at the various temperatures by each scorer is given in Table 8 and shown graphically in figure 26.

The tables show, as would be expected, a marked difference between the unpasteurized and the pasteurized cream butter. They indicate also that pasteurizing temperatures between 60° and 66° C. (140° and 150° F.) leave in the cream some factors causing a deterioration of the butter. Good results were secured from the cream pasteurized at 71° C. (160° F.). At 81° C. (180° F.) some of the samples were marked scorched or cooked.

[1] The authors acknowledge their indebtedness to Mr. P. H. Keiffer, of Gude Bros. Keiffer Co.; Mr. Cromer, of the Fox River Butter Co.; and Mr. John B. Newman, assistant food and dairy commissioner of Illinois, who kindly scored the butter.

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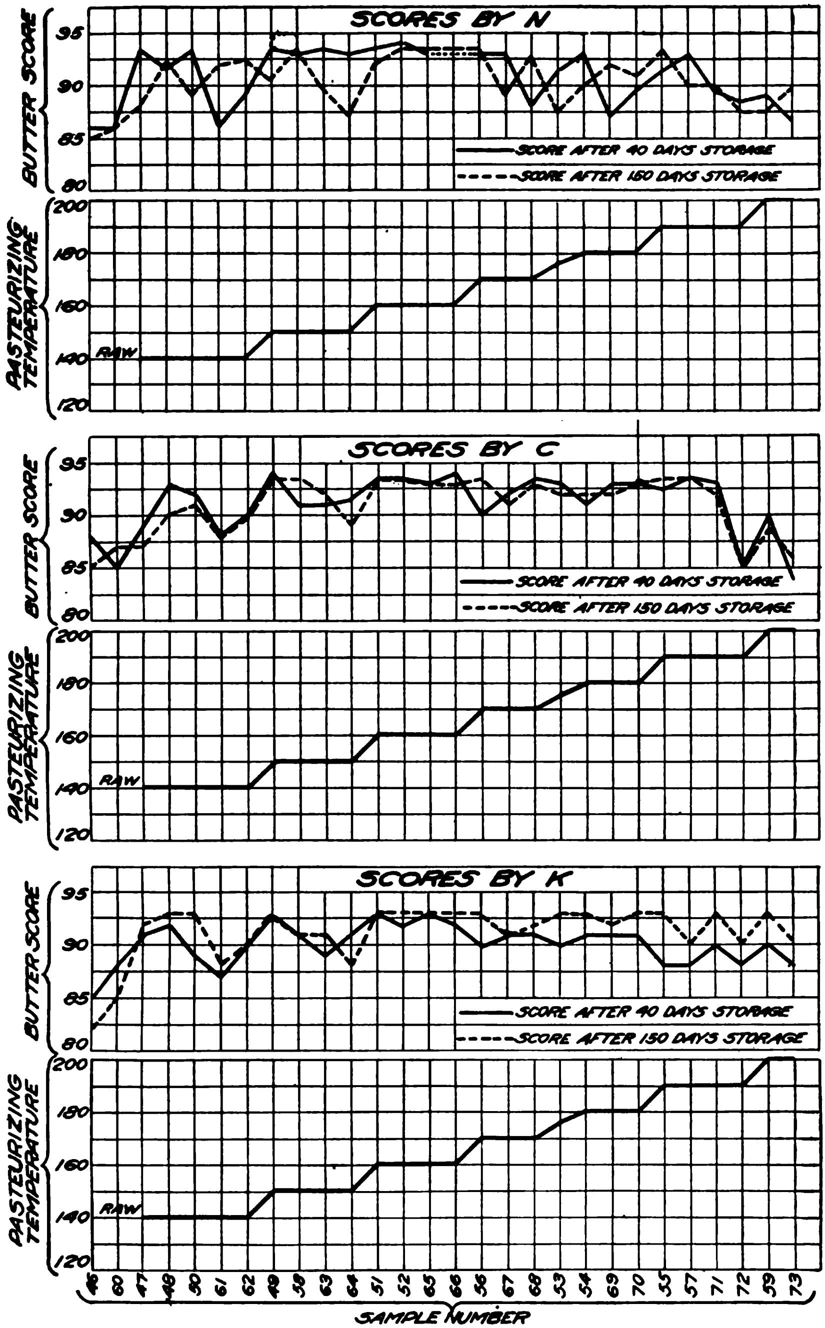

FIG. 25.—Effect of pasteurization temperature of cream on quality of storage butter. (See Table 7.)

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At 88° and 93° C. (190° and 200° F.) the quality of the butter was noticeably affected by the high heat, although some of the scorched flavor disappeared on long standing. The temperature at which cream acquires a scorched flavor is no doubt influenced by the amount of fat in the cream, the promptness of the cooling process, the relation of the amount of cream pasteurized to the capacity of the pasteurizer, and possibly other factors. The upper limit of pasteurization therefore can not be determined arbitrarily, but is dependent on varying circumstances. Certainly nothing is gained by exceeding 82° C. (180° F.), and it is probable that there is no advantage in going above 77° C. (170° F.) except the increased certainty of the destruction of the organisms of tuberculosis. The lower limit of efficient pasteurization may be set at 71° C. (160° F.), although under ordinary conditions it will be much safer to use at least 74° C. (165° F.).

It should be remembered, however, that these statements apply only to the conditions under which this work was carried out; that is, the pasteurization, in a continuous machine, of sweet cream for buttermaking. If cream is pasteurized in a vat or other holding device lower temperatures may, undoubtedly, be used.

TABLE 7.—*Effect of pasteurization of cream at various temperatures on quality of storage butter.*

Sample No.	Pasteurizing temperature.		Scored by N.		Scored by C.		Scored by K.	
	°C.	°F.	40 days.	150 days.	40 days.	150 days.	40 days.	150 days.
46	Raw.	Raw.	86	85	88	85	85	82
60	Raw.	Raw.	86	86	85	87	88	85
47	60	140	93½	88	89	87	91	92
48	60	140	91½	92½	93	90	92	93
50	60	140	93½	89	92	91	89	93
61	60	140	86	92	88	88	87	88
62	60	140	89	92½	90	90	90	90
49	66	150	93½	90½	94	93½	93	93
58	66	150	93	93½	91	93½	91	91
63	66	150	93½	89½	91	92	89	91
64	66	150	93	87	91½	89	91	88
51	71	160	93½	92	93½	93½	93	93
52	71	160	94	93½	93½	93½	92	93
65	71	160	93	93½	93	93	93	93
66	71	160	....	93½	93½	93	92	93
56	77	170	93	93½	90	93½	90	93
67	77	170	93	89	92	91	91	91
68	77	170	88	93	93½	93	91	92
53	80	176	91½	87½	93	92	90	93
54	82	180	93	90	91	92	91	93
69	82	180	87	92	93	92	91	92
70	82	180	89½	91	93	93	91	93
55	88	190	91½	93½	92½	93½	88	93
57	88	190	93	90	93½	93½	88	90
71	88	190	89½	90	93	92	90	93
72	88	190	86	87½	85	85	88	90
59	93	200	89	87½	90	89	90	93
73	93	200	86½	90	84	86	88	90

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TABLE 8.—*Average butter scores.*

Number of tests.	Pasteurizing temperature.		Scored by N.		Scored by C.		Scored by K.	
	° C.	° F.	40 days.	150 days.	40 days.	150 days.	40 days.	150 days.
2	Raw.	Raw.	86	$85\frac{1}{2}$	$86\frac{1}{2}$	86	$87\frac{1}{2}$	$83\frac{1}{3}$
5	60	140	$90\frac{7}{10}$	$90\frac{3}{8}$	$90\frac{1}{3}$	$89\frac{1}{8}$	$89\frac{1}{3}$	$91\frac{1}{3}$
4	66	150	$93\frac{1}{4}$	$90\frac{3}{8}$	$91\frac{1}{10}$	92	91	$90\frac{3}{4}$
4	71	160	$93\frac{1}{3}$	$93\frac{3}{8}$	$93\frac{1}{10}$	$93\frac{1}{4}$	$92\frac{1}{4}$	93
3	77	170	$91\frac{1}{3}$	$91\frac{5}{8}$	$91\frac{3}{8}$	$92\frac{1}{2}$	$90\frac{3}{4}$	92
1	80	176	$91\frac{1}{2}$	$87\frac{1}{2}$	93	92	90	93
3	82	180	$89\frac{5}{8}$	91	$92\frac{1}{3}$	$92\frac{1}{3}$	91	$92\frac{2}{3}$
4	88	190	90	$90\frac{1}{4}$	91	91	$88\frac{1}{2}$	$91\frac{1}{2}$
2	93	200	$87\frac{3}{4}$	$88\frac{1}{4}$	87	$87\frac{1}{2}$	89	$91\frac{1}{2}$

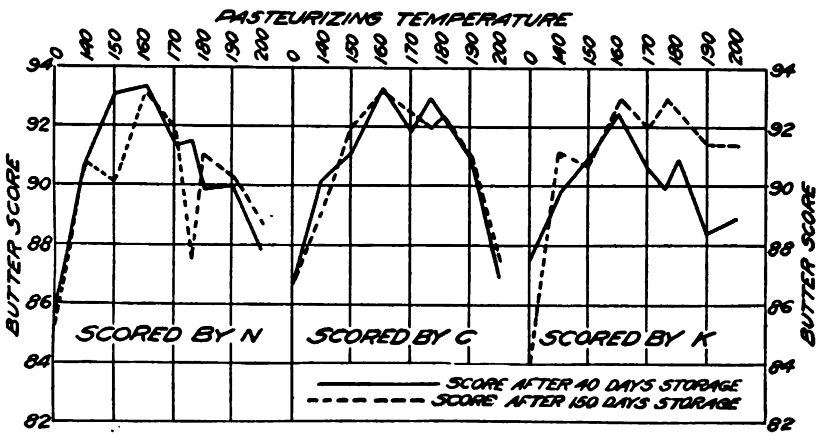

FIG. 26.—Average scores of butter, showing effect of pasteurization of cream at various temperatures.

SUMMARY.

The proper temperature for the pasteurization in a continuous machine of sweet cream for butter making was determined by observing (1) the temperature at which the greater part of the bacteria were destroyed, (2) the temperature at which the various enzyms of the milk were inactivated, and (3) the relative keeping quality of butter made from cream pasteurized at different temperatures.

The uniform destruction of the vegetative bacteria is uncertain at temperatures below 74° C. (165° F.).

Peroxidase was destroyed at 77° C. (170° F.), catalase and lipase at 70° C. (158° F.). Galactase was much weakened by temperatures between 71° C. (160° F.) and 77° C. (170° F.), but was not destroyed at 93° C. (200° F.), the highest temperature employed.

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Examination of the butter after storage indicated that pasteurization at 66° C. (150° F.) or lower left in the cream some factor causing a deterioration of the butter. This was not evident in the butter from cream pasteurized at the next higher temperature, 71° C. (160° F.), or higher. At 82° C. (180° F.) the flavor of the butter was affected by the heat. This action, however, may be controlled to some extent by the skill of the butter maker.

For the continuous pasteurization of sweet cream for butter making a temperature not lower than 74° C. (165° F.) nor higher than 80° C. (175° F.) is recommended.

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THE VACCINATION OF CATTLE AGAINST TUBERCULOSIS.

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INTRODUCTION.

The heavy annual losses which are caused by the ravages of tuberculosis among domesticated animals have been appreciated by the inhabitants of infected countries for many years. Owing to this realization of the extent of the havoc wrought by this insidious disease, earnest thought and study have been devoted by scientific forces in all civilized countries to the question of its eradication.

It was known from the first that the fight against tuberculosis among cattle would be a prolonged one because of the hidden manner in which the disease makes its attack, but when the suggestion was made that cattle might be safely and completely immunized against the disease the advantages which might arise from this method of procedure became at once apparent. It is obvious that if the young animals of an infected herd or locality can be thoroughly protected from tubercular infection the root of the matter has been reached, and it is then only a question of time when all the remaining animals can be disposed of and the premises can be cleaned and disinfected and kept free from tuberculosis.

An appreciation of the advantages accruing from immunization in our tuberculous herds led the Bureau of Animal Industry to inaugurate the tests here recorded. It was clearly seen that it was most desirable to devise some method whereby cattle could be immunized rapidly and without danger to themselves or their attendants. Therefore a number of the most promising methods of applying the immunizing agent have been tried, and while none of them have proved perfect, some have been more or less efficacious in enhancing the powers of resistance of the animals treated.

REVIEW OF RECENT LITERATURE.

At the Ninth International Congress of Veterinary Medicine, held at The Hague in September, 1909, the subject of immunization against tuberculosis received most interested attention, and the papers

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which dealt with this question were actively discussed. Among the opinions which were expressed during this discussion we quote from Dr. A. Eber, of Leipsic; Dr. J. F. Heymanns, of Ghent; Dr. Klimmer, of Dresden; Dr. Vallée, of Alfort; and Dr. Arloing, of Lyon.

Dr. Eber stated that the following conclusions had been reached by him after careful study of the entire question and after observing the results of numerous preventive inoculations:

The receptivity of young cattle to experimental infection by virulent tubercle bacilli may be materially diminished by previous inoculation with the Koch bacillus, even of varied origin and virulence.

The immunity thus conferred is not absolute. The immunized cattle will succumb from the effects of a sufficiently heavy dose of tuberculous virus.

The increase of resistance is not complete for some time (at least three months) after inoculation, and has entirely disappeared at the end of the first or second year.

The degree and duration of the experimental immunity are influenced by the individual resistance, and up to a certain point by the quality of the vaccine used.

No experimental method permits one to foresee the manner in which the vaccinated animals will comport themselves toward natural or enzootic contagion. Practice alone must decide the value of immunization in the struggle against bovine tuberculosis. Tuberculin does not positively disclose the existence of tuberculous centers upon animals previously treated by injections of living tubercle bacilli.

Science has not yet granted us a method of inoculation which permits effective struggle against tuberculosis in regions seriously infected.

The new researches simply shed a light upon preventive inoculation when combined with other prophylactic measures (killing animals affected with open tuberculosis, raising the calves on sterilized milk, plowing pastures) during the struggle against tuberculosis.

In practice one prefers methods of immunization which permit annual reinoculation. Nevertheless, more exact researches must be instituted for the purpose of determining if annual preventive inoculation is sufficient in every case to confer satisfactory immunity.

It is of great importance for the future to study further the influence of the mode of inoculation (intravenous, subcutaneous, digestive) upon the quality and duration of the immunity acquired, keeping constantly in mind at the same time the various doors of entrance of natural infection (digestive or respiratory).

Dr. Heymanns limited his report to a discussion of the method which he discovered, and which consists in inserting into the animal vaccinated the unattenuated tubercle bacilli inclosed within a dialyzing membrane.

Healthy animals thus vaccinated offer greater resistance to infection, whether by inoculation or stabling, than the checks. Although the duration and the degree of immunity are limited, the results obtained during four years upon more than 10,000 subjects have been most encouraging.

In practicing annually tuberculination and vaccination of all the cattle in contaminated stables without separating the tuberculous

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from the nontuberculous and without heating the milk, 86 per cent of the tuberculous centers have been practically wiped out after three or four years without the appearance of any serious trouble during the experiment. Upon stables more seriously contaminated Heymanns recognizes the fact that simple vaccination and tuberculination are ineffective, because the healthy cattle reinfect themselves in proportion to the intensity of the contagion. Upon such farms, in addition to vaccination, appropriate prophylaxis must be imposed.

The tuberculous cattle vaccinated and tested with tuberculin annually react less and less to the tuberculin, and by the third application of the tuberculin test 50 to 60 per cent of them fail to show any thermic elevation whatever.

The results of more than 1,000 autopsies upon vaccinated cattle indicate that in general healthy cattle that have been vaccinated have remained immune to tuberculosis and that the tuberculous animals, having ceased to react to tuberculin, present an arrested tuberculosis, even a regression, but the total absence of tuberculous lesions is exceptional.

In conclusion, Heymanns states that his antituberculous vaccination is a method practical and efficacious and, taken together with prophylactic measures, forms a valuable base in the struggle against tuberculosis, permitting one to struggle victoriously against this foe of our stables and this danger of infection to man.

Dr. Klimmer has examined the following methods of vaccination: First, the bovo-vaccination of Von Behring; second, the vaccination with "tauruman" of Koch and Schütz; third, the method of Heymanns; and fourth, the method of Klimmer.

The method of Klimmer consists in vaccinating with attenuated human tubercle bacilli. The nontuberculous animals are vaccinated twice during the first year, and those that are tuberculous are vaccinated every three months. The following year all the animals are vaccinated but once.

The preventive methods of Von Behring and of Koch and Schütz have proven practically inefficient. The reason is found in the short duration of the immunity which they produce and in the impossibility, while following sanitary regulations, of revaccinating either with bovo-vaccine or the tauruman.

Klimmer claims that it is not possible at this date to estimate the curative value of the method devised by Heymanns.

The method of Klimmer has not yet been sufficiently tested. Nevertheless, out of 43 vaccinated animals which had been exposed, some of them during many years, to natural tuberculous contagion, not a single one had developed tuberculosis up to the time of his report. Tuberculous young cattle have been vaccinated and from one to three years later have been killed, when autopsy has shown

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that the progress of the disease has been arrested, the tuberculous centers have become encapsulated and frequently calcified, and that there has been no formation of new tuberculous centers.

Dr. Vallée believes that we must recognize that, in spite of the enormous benefits realized on all sides, none of the proposed methods of vaccination has yet furnished definite results. He states:

I. Nevertheless, the inoculation of cattle by any method with virulent human tubercle bacilli confers an appreciable resistance against various methods of experimental infection and also against natural contagion.

II. The resistance conferred is directly proportional to the quantity and virulence of the bacilli injected, but however great their value, the immunity conferred by them does not persist longer than 12 to 18 months.

III. The introduction of living bacilli as a vaccine contaminates the entire organism. This peculiarity necessitates a special guard over the animals immunized, should they be sent to slaughter during the six months which follow the last vaccination.

IV. Whatever the mode chosen for introducing the vaccine, the resistance conferred is insufficient to assure the complete resorption of the bacilli inoculated for prolonging immunity.

V. The resistance to infection by the digestive tube of the animal vaccinated by that method is incomparably superior to that acquired by animals by the intravenous method, because it permits the organism to obtain complete resorption of the virulent material inoculated. Considering the frequency of infection through the digestive canal in cattle, the application of vaccinating material through the mouth appears preferable to every other method.

VI. Vaccination by the digestive method can not be made entirely free from danger of infection if one uses virulent bacilli of the bovine type. The use of bacilli of the human type of slight virulence is, therefore, preferable, as these furnish results comparatively equal to those of the bovine type.

VII. Vaccination by way of the mouth is not easily obtained except upon very young subjects.

VIII. Vaccination by way of the mouth does not place the animals entirely beyond danger of infection with tuberculosis. It permits them to resist for more than a year contact with cattle which present open lesions of tuberculosis and, following this, present no lesions beyond insignificant tubercular nodules in the various glands. On this account it merits systematic study and further practical application.

IX. The resistance conferred by subcutaneous methods is inferior to that obtained by way of the circulation.

X. Vaccination by the use of killed bacilli has given results inferior to those obtained with living and virulent organisms.

XI. No definite conclusion can yet be actually formulated in regard to the various methods of immunization under discussion, but their systematic application will permit a determination of their real practical value.

The method of immunization proposed by Arloing does not exactly resemble any of the other systems which are at present in use. Most of these latter methods depend on the employment of attenuated tubercle bacilli, but the vaccines employed by Arloing are not composed of bacilli modified specially in any case either by heat or antiseptics or by a passage through the organisms of cold-blooded or

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other animals. On the contrary, his vaccine contains living bacilli of bovine origin profoundly modified in their tubercle-producing power by a long series of cultures in the depth of glycerinated bouillon. The modifications which they have taken on are henceforth fixed and of such a kind that these bacilli form races indefinitely transmissible. These races, comparable to the antianthrax vaccines of Pasteur, can no longer cause tuberculosis of the viscera and glands under the conditions where they are recommended to be employed. Being without danger to the monkey, Arloing considers that they are also without danger to man. By their characters these vaccines are somewhat similar to the virulent vaccines of Prof. Klimmer, of Dresden. They can not cause any fatal infection in the ox, which is contrary to the bovo-vaccine of Von Behring and the tauruman of Koch and Schütz, since these may be fatal to from 7 to 8 out of every 1,000 subjects vaccinated.

Arloing concludes by stating that the phase of experimental researches in tuberculosis vaccination is not closed, and it is to be hoped that by perseverance in laboratory studies the methods will be perfected, and we will know better the conditions which follow and those which guarantee success. But such as they are to-day, it would be negligent not to profit by the results acquired to try and restrain the ravages of bovine tuberculosis by associating vaccination with ordinary prophylactic measures, as one does for other contagious maladies.

As a result of these various papers and the discussions which they elicited, the following resolutions were adopted by the Ninth International Congress held at The Hague in 1909:

1. At the present time there is no vaccination which in itself is sufficient to combat in an efficient manner bovine tuberculosis in heavily infected herds.
2. In how far it is possible to bring about a more successful issue of the difficult struggle against bovine tuberculosis by a combination of vaccination with prophylactic and hygienic measures must be demonstrated by new practical experiments.
3. The congress urgently requests the Governments to grant the means for extensive experiments to examine the methods of vaccination against bovine tuberculosis under the different conditions of agricultural practice.

THE BUREAU EXPERIMENTS.

Probably no methods for the immunization of cattle against tuberculosis have been more widely discussed or have given better results than those known as Pearson's and Von Behring's. The two are practically alike, and consist of the intravenous injection of living cultures of human tubercle bacilli of a virulence too low to cause a progressive tuberculosis in cattle. The tubercle bacilli are grown in artificial cultures, and, in a very finely subdivided condition, suspended in fluid in definitely known quantites, are injected into a vein of the animal to be protected. The methods of bovo-vaccination of

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Pearson and Von Behring were both tested, with what results will follow later.

In addition to studying these methods, attempts were made to cause immunity by subcutaneous injections of tubercle bacilli of different degrees of virulence as well as by the transfusion of blood from artificially immunized to susceptible animals.

Finally, a test was made of what is known as Heymanns's capsule method of protective treatment, for the efficiency of which the discoverer, after applying it to a large number of animals in his own country, makes very strong claims.

TEST ACCORDING TO VON BEHRING'S METHOD.

On June 2, 1906, the first nine calves and on June 12 the tenth calf in the following list were given each an intrajugular injection of 3 cubic centimeters of a suspension of tubercle bacilli of the human type. The tubercle bacilli used to make the suspension were from what was known as "Case 30," and each cubic centimeter of the suspension was equal to 0.0013 gram of tubercle bacilli:

Bull calf No. 427, about 2 to 2½ months old.
Bull calf No. 429, about 2 to 2½ months old.
Bull calf No. 431, about 2 to 2½ months old.
Heifer calf No. 432, about 2½ to 3 months old.
Heifer calf No. 435, about 2 to 2½ months old.
Heifer calf No. 436, about 2 to 2½ months old.
Bull calf No. 438, about 2 to 2½ months old.
Bull calf No. 439, about 2½ to 3 months old.
Bull calf No. 441, about 2 to 2½ months old.
Bull calf No. 444, about 3 to 3½ months old.

The ages of the calves as above given refer to the date on which the injections were made.

With the exception of a subsequent brief elevation of temperature and the development of a small tumor in the skin over the jugular at the point of injection in several of the calves, the injections were followed by no marked adverse conditions.

On September 7, 1906, each of the 10 calves was given a second intrajugular injection of tubercle bacilli prepared from culture "Case 30." The suspension used for the second injection, of which the dose was 3 c. c., represented 0.02 gram of tubercle bacilli per cubic centimeter.

The second injection was followed by a more marked elevation of temperature than the first, which may, in part at least, be attributed to the mechanically irritant action of the injected tubercle bacilli in the fine pulmonary capillaries.

Of the 10 calves, 1 (No. 444) was killed and examined post-mortem without being exposed to tuberculosis to determine what changes had

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been caused by the injections of tubercle bacilli it had received. The remaining 9 were exposed to a tuberculous environment, as follows:

Nos. 427 and 432, October 30, 1906.
Nos. 429 and 435, February 27, 1907.
Nos. 431 and 436, April 25, 1907.
Nos. 438 and 441, July 25, 1907.
No. 439, November 8, 1907.

Control animals were added at the time of each exposure, but as a matter of convenience the controls will be treated separately, as such treatment will facilitate a better comparison between the several protective methods against tuberculosis that were tested.

The tuberculous environment to which the animals used in these experiments were exposed was a large cow stable with an adjacent cow yard. In this stable and yard the infection was provided by a number of cattle affected with advanced tuberculosis, of which it was definitely known that they were freely expelling tubercle bacilli. In the yard into which the cattle were turned daily for from 2 to 8 hours, depending upon the state of the weather, all the cattle treated, checks and diseased, were allowed to mingle as they chose; in the stable the cattle were made to occupy stalls in such rotation that the exposure of the different individuals was equalized as much as possible.

The dates on which the 10 calves were killed and a short memorandum of the lesions found on autopsy follow:

No. 444, treated but not exposed, reacted to tuberculin October 17, 1907 (13 months after last bovo-vaccination injection). Killed November 7, 1907. No lesions found, but firm pulmonary adhesions and one small glistening nodule, 3 mm. in diameter, in the lung. No tubercle bacilli on microscopic examination or animal inoculation were found in the minute glistening nodule, which may have been a small healed tubercle caused by bacilli from one of the intravenous injections.

No. 427, killed April 23, 1908, after having been exposed to a tuberculous environment for about 18 months. No lesions of tuberculosis.

No. 432, killed March 9, 1909, after having been exposed to a tuberculous environment over 2 years. No lesions of tuberculosis.

No. 429, killed July 16, 1909, after having been exposed to a tuberculous environment over 2 years. No lesions of tuberculosis.

No. 435, killed April 10, 1909, after having been exposed to a tuberculous environment over 2 years. One post-pharyngeal gland twice the normal size and almost entirely tuberculous. No other lesions.

No. 431, killed March 25, 1909, after having been in a tuberculous environment almost 2 years. Mediastinal glands contained a number of minute necrotic foci which failed to show the presence of tubercle bacilli on microscopic examination and guinea-pig inoculation. Lungs contained a number of minute areas which had the appearance of healing tubercles; no bacilli found in these areas.

No. 436, killed March 29, 1909, after having been in a tuberculous environment almost 2 years. No lesions of tuberculosis.

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No. 438, killed April 10, 1909, after having been in a tuberculous environment over 2 years. No lesions of tuberculosis.

No. 441, killed April 9, 1909, after having been in a tuberculous environment over 2 years. Autopsy showed minute lesions in the azygos lobe of lung and a small focus 3 mm. in diameter in the right prescapular gland. No tubercle bacilli found in the lung lesions. The prescapular lesions showed tubercle bacilli on microscopic examination and guinea-pig inoculation.

No. 439, killed March 29, 1909, after having been exposed about 16 months to a tuberculous environment. Tubercles in the posterior mediastinal glands, which on guinea-pig inoculation caused generalized tuberculosis.

TEST ACCORDING TO PEARSON'S METHOD.

On June 2, 1906, the first 9 calves, and on June 12, the tenth calf in the following list were given each an intrajugular injection of 3 c. c. of a suspension of tubercle bacilli of the human type. The tubercle culture used to make the suspension was "Case 32," and each cubic centimeter of the suspension was equal to 0.0013 gram of tubercle bacilli.

Heifer calf No. 412, about 4 months old.
Heifer calf No. 413, about 3 months old.
Bull calf No. 425, about 2½ to 3 months old.
Bull calf No. 426, about 2½ to 3 months old.
Bull calf No. 428, about 2½ to 3 months old.
Heifer calf No. 430, about 2½ to 3 months old.
Bull calf No. 433, about 2½ to 3 months old.
Bull calf No. 440, about 2½ to 3 months old.
Heifer calf No. 442, about 2½ to 3 months old.
Heifer calf No. 445, about 3 months old.

The ages of the calves as given above refer to the date on which the injections were made.

On July 18, 1906, the 10 calves were given a second intrajugular injection of a suspension of tubercle bacilli in all respects relative to dose and strength similar to the first injection.

On September 11, 1906, the calves received a third intrajugular injection of a suspension of tubercle bacilli. The third dose, like the other two, was 3 c. c., but the suspension was stronger, 1 c. c. being equal to 0.002 gram of tubercle bacilli.

With the exception of some elevation in temperature, most marked after the third injection, the calves showed no pronounced symptoms as the result of the injections.

Of the 10 calves, 1 (No. 445) was killed and examined post-mortem without being exposed to tuberculosis, to determine what lesions, if any, had been caused by the three injections of tubercle bacilli. The remaining 9 calves were exposed to a tuberculous environment, as follows:

Nos. 412 and 425, October 30, 1906.
Nos. 413 and 426, February 21, 1907.
Nos. 428 and 430, April 25, 1907.
No. 440, November 8, 1907.

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Control animals were added at the time of each exposure. The character of the tuberculous environment has already been described.

The dates on which the 10 calves were killed and a short memorandum of the lesions found on autopsy follow:

No. 445, treated but not exposed, reacted to tuberculin October 17, 1907 (about 13 months after last bovo-vaccination injection), killed November 7, 1907. No lesions of disease.

No. 412, killed April 23, 1908, after having been exposed to a tuberculous environment about 18 months. No lesions of disease.

No. 425, died December 18, 1906, after having been exposed to a tuberculous environment about 6 weeks. Cause of death, inflammation of the intestines. No lesions of tuberculosis.

No. 413, killed August 9, 1909, after having been exposed to a tuberculous environment over 2 years. No lesions of disease.

No. 426, killed April 1, 1909, after having been in a tuberculous environment over 2 years. Lungs were found to contain a few very minute tubercles.

No. 428, killed March 29, 1909, after having been in a tuberculous environment nearly 2 years. No lesions of tuberculosis.

No. 430, killed March 22, 1909, after having been in a tuberculous environment nearly 2 years. The pleura and mediastinal glands showed minute lesions closely resembling tuberculosis, but no tubercle bacilli could be found in these lesions by microscopic examination or guinea-pig inoculation.

No. 433, killed July 16, 1909, after having been exposed to a tuberculous environment about 2 years. No lesions of tuberculosis.

No. 442, killed July 16, 1909, after having been exposed to a tuberculous environment about 18 months. No lesions of tuberculosis.

No. 440, killed April 10, 1909, after having been exposed to a tuberculous environment nearly 18 months. No lesions of tuberculosis.

VACCINATION BY SUBCUTANEOUS INJECTIONS.

INJECTIONS INTO THE END OF THE TAIL.

As the earlier investigations of the Bureau of Animal Industry on the subject of protective inoculations against tuberculosis (see Bulletin 52, Part III) had given results indicating that the degree of immunity conferred by the injection of living tubercle bacilli into the bodies of cattle depended rather upon the virulence of the in-injected bacilli than upon the method of injection or the number of injections, a series of tests was made relative to the effects from injecting cattle with quite virulent tubercle bacilli into a portion of the body (the end of the tail) from which the infection, with its strong tendency to become localized, would have to move some distance before it could reach its favorite location in the body. The end of the tail also offered the advantage that the character and process of the inoculation disease could be watched and that treatment, surgical if necessary, could be applied.

On June 20, 1906, the following 4 calves received each a subcutaneous injection, immediately above the brush at the end of the tail, of 3 c. c. of a suspension of bovine tubercle bacilli. The tubercle

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culture used was "Bovine III," and each 3 c. c. of the suspension was equal to 0.01 gram of tubercle bacilli.

Heifer calf No. 447, about 3 months old.
Heifer calf No. 448, about 3 months old.
Bull calf No. 450, about 3 months old.
Bull calf No. 451, about 2½ months old.

The tuberculous disease caused in the tails of the animals varied considerably. In one case, No. 447, it was necessary to amputate the tail. The four animals were exposed to a tuberculous environment beginning some time after the protective injections had been made. Later on, when they were killed and examined post-mortem, all with the exception of No. 450 were found to have tuberculous lesions directly traceable to the tubercle bacilli injected into the ends of their tails, proving definitely that the strain of tubercle bacillus used was too virulent for the injection of calves in any manner.

Calf No. 450, after remaining in a tuberculous environment for several years, was found on autopsy to be in excellent condition and entirely free from lesions of tuberculosis.

On June 20, 1906, the following 5 calves received each a subcutaneous injection, immediately above the brush at the end of the tail, of 3 c. c. of a suspension of a virulent human tubercle bacilli. The tubercle culture used was "Boy V," and each cubic centimeter of the suspension represented 0.01 gram of tubercle bacilli.

Heifer calf No. 449, about 3½ months old.
Bull calf No. 452, about 2½ months old.
Bull calf No. 453, about 2½ months old.
Bull calf No. 454, about 3 months old.
Heifer calf No. 455, about 3 months old.

With the exception of a slight swelling at the seat of injection, which gradually subsided, the treatment received by the calves caused no visible lesions.

Some time after the protective injections were made the calves were exposed to a tuberculous environment, and later on they were killed and examined post-mortem.

Calves 449 and 453 showed no lesions of tuberculosis as a result of either the protective injections or the exposure.

Calves 452 and 454 each showed a small tuberculous abscess at the seat of inoculation in the tail and small tuberculous foci in the coccygeal lymph glands (the lymph glands located near the root of the tail), and no lesions as a result of the exposure to tuberculosis after the protective injections had been made.

Calf 455 was found on autopsy to have tuberculous lesions in the coccygeal and pharyngeal glands, or, in other words, to have contracted tuberculosis both from the protective injection and the subsequent exposure.

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All the tuberculous lesions found were small, but calves 452, 454, and 455 show conclusively that the strain of tubercle bacillus injected was too virulent to be used for immunizing purposes. Calves 449, 452, 453, and 454 indicate that even a subcutaneous injection of tubercle bacilli can protect against subsequent exposure to a tuberculous environment, and No. 455 shows that a tuberculous process induced by inoculation does not necessarily, in all instances, protect against fresh infection from without, and this is one of the most important facts with which we have to deal in the question of bovo-vaccination.

On November 14, 1906, the following cattle received each a subcutaneous injection, immediately above the brush at the end of the tail, of 3 c. c. of a suspension of bovine tubercle bacilli. The tubercle culture used was "Bovine III," and each cubic centimeter of suspension was equal to 0.01 gram of tubercle bacilli.

Heifer No. 406, about 18 months old.
Heifer No. 386, about 16 months old.
Cow No. 336, about 3 years old.
Cow No. 215, about 6 years old.

One of the above animals (cow No. 336) died about four months after injection without additional exposure to tuberculosis. The cause of death was inflammation of the intestines, but she showed a well-marked tuberculous lesion in her tail at the seat of injection and tuberculous lesions in four mediastinal glands. All other parts of her body were free from tuberculosis.

Heifers 406 and 386 and cow 215 were killed after having been exposed to a tuberculous environment for quite a long time, and showed tuberculous lesions which might have been caused in part by the exposure, and which were certainly caused in part by the injection of tubercle bacilli.

INJECTION UNDER THE SKIN OF THE NECK.

On June 21, 1906, the following 5 calves were each injected with 3 c. c. of a suspension of virulent human tubercle bacilli. The dose in each case was divided into two parts, and one part was introduced under the skin on the right side of the neck and the other part under the skin on the left side of the neck. Each 3 c. c. of the suspension injected represented 0.01 gram of tubercle bacilli.

Bull calf No. 456, about 2½ months old.
Bull calf No. 457, about 3 months old.
Bull calf No. 458, about 2½ months old.
Heifer calf No. 459, about 2½ months old.
Heifer calf No. 462, about 2½ months old.

Calves 458 and 462 died in about two months as a result of tuberculosis caused by the injection of tubercle bacilli. The remaining

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three animals were exposed to a tuberculous environment for some time and were subsequently killed and examined post-mortem. All showed extensive lesions of tuberculosis, no doubt almost entirely due to the injection of tubercle bacilli, showing that either this method of treatment was too severe or that the culture of tubercle bacilli used was too virulent.

In addition to the foregoing subcutaneous injection, 10 calves, Nos. 446, 460, 463, 464, 465, 466, 469, 470, 473, and 474, were each given two successive injections of virulent tubercle bacilli, with an interval between the two injections. These calves all contracted tuberculosis from the treatment received, and simply emphasized that subcutaneous injections, no matter what part of the body is used as the seat of injection, are dangerous when the bacilli injected have a true virulence for cattle. In a later and fuller report on this work it is expected that the lesions caused by the various injections may be given and discussed in detail.

Among the subcutaneous injections only those made into the ends of the tails of calves 449, 452, 453, 454, and 455 with virulent human cultures hold out any encouragement that a subcutaneous method of protective inoculations against tuberculosis can be developed. The results with these animals, however, are quite encouraging and indicate the advisability of making tests of successive injections into the tails of cattle, beginning with fairly virulent cultures.

CHECKS OR CONTROL ANIMALS.

The following 11 untreated cattle, which were similar in age, size, and condition to those given intravenous protective treatment according to the methods of Pearson and Von Behring, were exposed for the same length of time to the same tuberculous environment to which the treated or protected animals were exposed. For the sake of brevity only a sufficient account of these animals will be given now to show that the environment contained the necessary amount of virulent, infectious material to cause tuberculosis of most cattle exposed in it.

Heifer No. 471 contracted tuberculosis of the mediastinal and mesenteric glands.

Heifer No. 472 contracted tuberculosis of one post-pharyngeal gland.

Heifer No. 475 contracted tuberculosis of the mediastinal glands.

Heifer No. 526 contracted tuberculosis of the mediastinal glands.

Steer No. 530 contracted tuberculosis of the lung and mediastinal glands.

Steer No. 531 remained healthy.

Heifer No. 539 contracted tuberculosis of one post-pharyngeal gland.

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Heifer No. 540 contracted generalized tuberculosis.

Heifer No. 570 contracted tuberculosis of the mediastinal glands.

Bull No. 573 contracted tuberculosis of the lung and mediastinal glands.

Cow No. 579 remained healthy.

Of course it is to be understood that these cattle were carefully tested with tuberculin and found to be free from tuberculosis before they were exposed as control animals in the experiment. It is desired to avoid all detail not to some extent essential for a general statement in the present report.

In addition to the check or control cattle specially related to the tests of the Pearson and Von Behring methods of bovo-vaccination, three other check animals were also introduced into the same tuberculous environment, which was in all instances used as the means to test the amount of immunity acquired by the treated animals in these series of experiments. The three additional animals were Nos. 477, 484, and 549, and all three contracted tuberculosis as the reuslt of the exposure.

There was thus a total of 14 checks or controls, of which 12 became infected with tuberculosis, thus showing that the character of the exposure to which the treated cattle were subjected was quite severe. The time at which the various control animals were introduced into the tuberculous environment and the length of time they were permitted to remain in it were carefully planned in connection with the exposure of the treated animals, so that any failure among the latter to become infected could be properly valued through a comparison of the treated with the control animals.

One statement which has an important bearing on the intravenous methods of producing resistance against tuberculosis must be added here. All our cattle treated with intravenous injections of tubercle bacilli showed, on careful post-mortem examination, some pulmonary lesions, such as thickening of the pulmonary connective tissue, adhesions between the lobes of the lungs and of the lungs to the chest wall and diaphragm, to be sure only very slight in most instances, but which could be accounted for in no other way than as remnants of the disturbance caused by the injected bacilli. This alone constitutes a condition which should receive further attention before a system of bovo-vaccination requiring the intravenous injection of living cultures of tubercle bacilli is practiced on a wholesale scale, and, in conjunction with what we know about the retention of tubercle bacilli in the tissues after injection and the uncertainty about the manner and state in which they leave the body, should teach us to proceed cautiously in the adoption of protective methods, notwithstanding the fact that the results obtained prove conclusively that actual, strong resistance to tuberculosis can be established by using them.

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COMPARISON OF THE FOREGOING METHODS.

From the brief accounts that have been given we see that 3 of the 9 cattle treated according to the method of Von Behring and afterwards exposed contracted tuberculosis, that 1 of the 9 cattle treated by the method of Pearson and afterwards exposed contracted tuberculosis, and that of 14 checks or untreated control animals 12 became infected on exposure.

Of the 8 animals that received injections of bovine tubercle culture subcutaneously into the ends of their tails (4 old and 4 young animals), all but 1 young animal contracted disease as the result of the injections. The one that escaped disease from the injection also resisted tuberculosis on exposure.

Of the 5 cattle that received human culture injections into the ends of their tails, 2 became immune without inoculation disease, 2 were immune but had slight inoculation disease, and 1 had both inoculation and exposure disease.

The injection of tubercle cultures under the skin of the neck of animals caused them all to contract tuberculosis.

The several methods may be compared as follows:

Von Behring cattle, 66⅔ per cent successfully protected for a period approximating 2 years.

Pearson cattle, $88\frac{8}{10}$ per cent successfully protected for a period approximating 2 years.

Bovine cultures, tail, protected 12½ per cent.

Human cultures, tail, protected 40 per cent.[1]

Injections under skin protected 0 per cent.

The above percentages can best be valued by comparing them with the check or control animals, among 14 of which only 2, or $14\frac{2}{7}$ per cent, escaped.

If the only question to be considered in connection with bovovaccination was the protection of cattle against tuberculosis, the foregoing results would give us excellent reasons to be very cheerful. Lately, however, studies made by various investigators on the elimination of tubercle bacilli, after injection, from the bodies of animals teach us to be very careful about adopting methods of immunization for purely economic purposes that may be dangerous for those who afterwards use the products of the treated animals.

The work of the Bureau of Animal Industry in the past has also demonstrated that tubercle bacilli injected into the circulation or under the skin of cattle may remain incorporated in their tissues for long periods of time, with only a gradual or very slow loss of virulence. These are important factors that must not discourage further work to build on the knowledge we have gained, but which must be

[1] It should be borne in mind that the human cultures injected in the tail actually protected 80 per cent of the cattle treated against the infection in the environment to which they were exposed.

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kept in mind and be permitted to have their due influence on our subsequent investigations.

Very careful autopsies of cattle treated by intravenous inoculations of tubercle bacilli according to the methods of Von Behring and Pearson show that the more or less attenuated tubercle bacilli that engender immunity against tuberculosis rarely leave the treated subjects wholly free from lesions that can be accounted for in any other way than as due to the pathogenic activity within the animal's body of the injected bacilli.

TEST OF THE HEYMANNS METHOD OF BOVO-VACCINATION.

A protective treatment for cattle against tuberculosis, named the Heymanns method after its inventor, has received considerable attention during the last few years. The technique of this method was demonstrated in America by Prof. Heymanns himself during the meeting of the International Congress on Tubercuolsis at Washington in 1908, and the efficiency of the method has been carefully tested by the Bureau of Animal Industry with cattle and hogs.

Heymanns's method, briefly, is the introduction of virulent bovine tubercle bacilli, enveloped in a closed sack of vegetable fiber, which in turn is inclosed in a gelatin capsule, under the skin of the animal to be protected. The supposition is that the vegetable sack will confine the tubercle bacilli at the seat of inoculation and that the treated animal will be immunized by protective fluids that form within the closed vegetable sack and pass outward from it, into the animal's system generally, by an osmotic process. The closed sack of vegetable material in combination with the gelatin capsule is commonly known as the Heymanns capsule.

In the fall of 1908, 12 cattle and 10 hogs were inoculated with Heymanns's capsules. The animals were divided into three groups, and one group of hogs and cattle was exposed immediately after treatment to a tuberculous environment, a second about 2 months later, and a third about 2 months after the second. With each group of hogs a similar number of untreated hogs were exposed as checks. As the cattle and hogs were exposed in the same tuberculous environment in which the degree of immunity acquired by all the other bovovaccinated animals discussed in this paper was tested, no checks were really necessary for the Heymanns treated cattle. The checks on the other experiments were serviceable for this one also, but, nevertheless, 4 additional cattle as special checks on the value of the Heymanns method were added to the already large number used to prove the character of the tuberculous environment to which exposure was made.

Among the Heymanns treated hogs 1 contracted generalized tuberculosis from the treatment and 1 died prematurely as the result of

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an injury. When the remaining 8 hogs with their 10 checks were killed, after an exposure to natural infection varying from 8 months to a year, all the principals and checks were found to be affected with tuberculosis, not one of either lot having escaped the disease; and the lesions in the treated animals were in no respect different from those found in the checks. Hence it is very clear that Heymanns's method is absolutely worthless for hogs.

Among the 12 cattle treated 1 died prematurely, and the remaining 11, when they were killed and examined post-mortem, all showed lesions of tuberculosis, and the lesions were very similar to the tuberculous lesions found in the 4 cattle that served as special checks on the Heymanns capsule cattle. One of the treated animals showed tuberculosis directly traceable to the capsule with which it was inoculated for protection. Hence, as with the hogs, the only conclusion that can be drawn with the cattle is that Heymanns's capsule method of bovo-vaccination is inefficient.

In order to test the claims made by Prof. Heymanns, that the vegetable sack in which he incloses the tubercle bacilli used in his method of bovo-vaccination would not permit the passage of bacteria, a number of sheep were inoculated with anthrax bacilli inclosed in Heymanns's capsules. The sheep rapidly contracted and succumbed to anthrax, and the anthrax bacilli (which are larger, of course, than tubercle bacilli) were proven to have escaped through the walls of the capsules and to have gotten into the blood circulation. Blood examined from the tips of the ears of the sheep showed numerous anthrax bacilli. We may conclude from this that the fact that tubercle bacilli introduced under the skin in Heymanns's capsules are frequently restrained at the point of inoculation depends upon other conditions than the inability of the germs to pass through the walls of the vegetable sack in which they are enveloped.

BLOOD TRANSFUSIONS.

It may be of interest to add a short note that blood transfusions from highly immunized cattle into tuberculous cattle for curative purposes and into healthy cattle in order to make them resistant to tuberculosis have been tested on a small scale. The idea that such transfusions may give good results originated with Dr. George W. Crile, of Cleveland, Ohio, who personally made the various transfusions required in the experiment.

The blood for the transfusions was supplied by cattle that had been immunized by the methods of Pearson and Von Behring and that had resisted infection after a long-continued exposure to the tuberculous environment previously described, in which about 86 per cent of all exposed, untreated, or check cattle contracted tuberculosis.

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As far as the very small number of cattle used justifies drawing conclusions, the blood-transfusion experiments gave wholly negative results and hold out no encouragement as being a means by which tuberculosis can be treated or the resistance to infection strengthened. The treated animals may have been too far advanced in the disease to derive benefit from any form of treatment, but the animals which received blood to immunize them apparently were as susceptible to infection as those that had received no treatment.

GENERAL CONCLUSIONS.

The only conclusion to which we are entitled from this work and from careful study of the writings of others on the subject of protective inoculation against tuberculosis may be stated as follows: Though results have been obtained which are very encouraging to the investigator and which prompt him to strive onward with renewed vigor and hope, no system of bovo-vaccination has reached a stage at the present time that justifies its use in common practice.

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VARIOUS METHODS FOR THE DIAGNOSIS OF GLANDERS.

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AND

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Since the discovery of the glanders bacillus in 1883 by Loeffler and Schütz the diagnosis of glanders has been the subject of numerous investigations, and as a result great progress has been made in its determination. The greatest difficulty in the recognition of this disease lies in the fact that many glandered horses do not show positive symptoms until the later stages of the disease. Horses affected with occult or latent glanders and which are apparently not even suspicious cases must be considered as the principal distributing agents of the infection. The early diagnosis of glanders is therefore one of its most important aspects to the practicing veterinarian. With a positive diagnosis definitely established in a stable of horses, subsequent action is clear as to the measures which should be taken to protect the owner from further loss and personal danger.

Our knowledge, methods, and resources in coming to the conclusion that a given horse is or is not affected with glanders has gradually broadened until to-day there are a number of distinct methods by which the diagnosis of glanders may be made, namely—

1. Physical examination.
2. Post-mortem examination.
3. Auto-inoculation.
4. Extirpation of the submaxillary gland.
5. Guinea-pig inoculations.
6. Mallein reaction (subcutaneous, ophthalmo, and cutaneous tests).
7. Serum agglutination reaction.
8. Precipitation reaction.
9. Complement-fixation test.
10. Combined complement-fixation and agglutination test.

PHYSICAL EXAMINATION.

In typical or advanced cases glanders can be definitely diagnosed by physical examination alone. And we are liable not to rely sufficiently on our powers of observation and differentiation in the diagnosis of this disease at the present day when biological tests are so

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easily made and laboratories are so much in evidence. The great drawback to physical examination alone is that a large percentage of the cases are not typical, and the so-called occult or latent cases do not show any physical signs. It is nevertheless absolutely essential to pick out these cases if the disease is to be suppressed. It is only too true that the present prevalence of glanders throughout the United States is mainly due to the fact that sufficient effort has not been put forth to get the occult or "contact" animal. We are too likely to content ourselves with the destruction of the more or less marked cases and leave the remaining animals free from quarantine, only to see them break down with the disease at some later date, and in the intervening period to spread the infection to a greater or less degree.

The physical manifestations of glanders are so well known that it is only necessary to lay stress on the most important symptoms to be noted. According to the chief points of localization of the glanders bacilli, we term the disease glanders or farcy. The name glanders is applied when the disease chiefly affects the nostrils and internal organs, while the term farcy is used when the skin is the seat of the disease. It must be understood, however, that glanders and farcy are the same disease, due to the same micro-organism, and vary only in the point of manifestations of the lesions. Farcy appears as swellings of the skin, which vary in size from a quarter to a silver dollar in circumference. They are round, hot, and sensitive to pressure. Soon the center breaks down and the skin sloughs off, leaving a depressed ulcer on the surface which discharges a yellowish serous oily fluid very characteristic to the experienced eye. The lymphatics leading from these ulcers soon become inflamed and stand out under the skin as tense cords, and new farcy "buds" are liable to break out at any point along their course. (See Pl. XXVI, fig. 1.) In glanders the lesions are frequently confined to the respiratory tract and are observable during life on the nasal septum. (See Pl. XXVI, fig. 2.) The lesions here appear first as small, raised nodules about the size of a pea. These soon break down in the center, leaving irregular, lead-colored ulcers, which discharge the same oily tenacious fluid as is seen coming from the farcy buds. As a result a mucopurulent nasal discharge is observed, which may be tinged with blood. In case the ulcers heal they leave irregular scars, which are known as the star-shaped scars of glanders and are quite characteristic. The lymphatic glands under the jaw become enlarged, indurated, and firmly attached to the bone. The above-described nodules and ulcers may occur on the windpipe or in any part of the bronchial tubes. The general condition of the animal becomes poor and the coat staring; otherwise no visible alterations are present, and the animal may live in this condition for years.

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FIG. 1.—FARCY AFFECTING SKIN OF SHOULDER.

FIG. 2.—LESIONS OF GLANDERS IN NASAL SEPTUM.

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In the acute form of the disease the symptoms are the same as those described in the chronic, except that the various stages are more intense and follow each other rapidly. There may be swelling of an entire leg, with numerous farcy buds breaking out, and the nasal septum may be covered with the small nodules and ulcers. The temperature is usually elevated to from 102° to 104° F., the breathing is rapid, and the patient somewhat resembles an animal suffering with pneumonia. The acute form leads to death, and in the chronic cases, which are not destroyed, death usually occurs as a result of the chronic form being accelerated into the acute through hard work or some other condition which reduces the vitality of the patient.

POST-MORTEM EXAMINATION.

This method of diagnosis is of value where a number of animals are showing more or less atypical evidences of glanders and other methods of diagnosis are not available. The animal appearing to be in the most advanced stage should be killed and a post-mortem made. The submaxillary lymph glands should be removed and examined. In cases of nasal glanders these are always involved and are swollen, and in old cases they are bound down to the inferior maxilla by connective tissue. On cross section the parenchyma will be found to contain one or several caseous or purulent centers from a pinhead to a pea in size. The nasal septum should be examined throughout its entire length, as ulceration may be present posteriorly, even though an examination of the anterior portion made during life shows an apparently normal septum. In the early stages of the disease on the nasal septum gray or yellowish nodules of the size of millet seed are present, which are surrounded by reddened mucous membrane. After the breaking down of the nodules ulcers develop, which, as a result of the progressing degeneration, become irregular in shape. (See Pl. XXVI, fig. 2.) Their base is frequently covered with pus and detritus or with a brownish scab. Small ulcers may coalesce, and in this manner large areas of ulceration result. The healed ulcers disclose an almost characteristic cicatrix in the form of a radiating scar, these scars, as before stated, being known as the star-shaped scars of glanders.

The lungs are affected in a large percentage of cases of the disease, and the infection here may be primary or secondary. McFadyean states that no cases of glanders have been recorded in which the lungs were not affected to a greater or less extent. The lungs usually manifest either tubercle-like nodules or lobular pneumonic areas as the initial lesions. The glanders nodule is the most characteristic finding in the lung. These vary in size and appearance in the same animal. They are usually of sizes from a pinhead to that of a pea,

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shot-like on palpation, and do not "shell out" readily from the surrounding tissue. In later stages of their development they are found in the center of small hemorrhagic-pneumonic islands. The older nodules are surrounded by firm fibrous capsules. On cross section the center is yellowish, caseous, or dry and crumbling. Calcareous deposits in old arrested glanders nodules may occur. These nodules are usually not in great abundance, and in advanced cases may not number more than 40 or 50 in both lungs. Larger numbers are quite rare.

A catarrhal pneumonic form of glanders of the lungs is manifested in atelectatic areas which have a brownish-red color. In a later stage, however, they break down as a result of a central softening, forming a yellowish caseo-purulent mass, and become surrounded by a red hepatized zone, which is very frequently infiltrated with a yellowish gelatinous exudate. In cases where the lungs show an extensive involvement an acute bronchitis is usually present in association with it. The mucous membranes of the bronchi in such cases show nodules or ulcerations besides the usual characteristics of this affection.

Other organs in which changes occur are the spleen and the liver. These quite frequently manifest small translucent nodules which contain either a yellowish pus or a dry mortar-like mass. The nodules in these organs are usually surrounded by a white dense connective-tissue capsule. Nodules of glanders have also been observed occasionally in the kidneys, brain, body musculature, and in the heart muscle. Of the bones, the ribs are most frequently involved, and in these different sized caverns form, which are filled with a yellowish tenacious substance. The corresponding lymph glands of the affected organs are also usually affected, showing acute swelling in fresh infections, while in chronic cases a dense tough indurated condition is noted.

A differential diagnosis of the nodules becomes very frequently necessary, and in such cases the nodules of anthracosis, metastatic pyemia, malignant tumors, and especially parasitic nodules come into consideration. The nodules of anthracosis are rare. They are small, usually contain pigment, and are composed entirely of fibrous tissue. In metastatic centers of pyemia the pus is more fluid, the connective tissue wall is thin, the condition is acute, and the primary seat of infection can usually be found. In metastatic tumors there are no fibrous walls surrounding the growth, and on cross section the tumor cuts easily and contains no central area of degeneration, but is homogeneous. The primary tumor can be found in some other part of the body. The parasitic nodules caused by the *Strongylus arnfieldi* and the *Ecchinococcus* are quite similar to glanders nodules. Parasitic nodules, however, no matter how small, are always surrounded by a capsule. The periphery is translucent and the center usually con-

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tains lime salts. In the large nodules the capsule is not thick as in the old caseous glanders nodules.

Nodular multiplex bronchitis, which is characterized by small, uniform, gray, frequently calcified nodules, may be mistaken for glanders. In the presence of this affection, however, the surrounding lung tissue appears normal; besides, the bronchial lymph glands show no involvement. In chronic interstitial pneumonia the interalveolar connective tissue is extensively and uniformly thickened and there are no nodules and no gelatinous infiltration present. In tuberculosis, which is very rare in horses, there are different sized nodules, some of which resemble sarcomatous growths, and there is also a caseation of the thoracic lymph glands. In botryomycosis and pneumomycosis the changes show a more chronic character, and in these infections a microscopical examination will readily disclose the character of the affection.

AUTO-INOCULATION.

Auto-inoculation consists in a cutaneous vaccination of the suspected horse with its own nasal or lachrymal discharge. It is carried out by shaving the hair and making an incision in the skin, with an ordinary clean scalpel, three-fourths to 1 inch in length and just deep enough to avoid drawing more than a drop of blood. With this same scalpel take up as much of the nasal discharge as will go on its end, and with the flat of the point rub it gently into the incision. The object is to encourage absorption of the virus, which would not be done if there were a large incision and a free flow of blood. The seat of the auto-inoculation must be at a point where it can not be licked or rubbed, and the most convenient point with these qualifications is about 8 inches below and posterior to the ear. In carrying out this procedure on a number of suspected animals, some of which are probably free from glanders, the knife must be thoroughly sterilized after each inoculation, otherwise hetero-inoculation may be produced and lead to very embarrassing results. Between each inoculation, therefore, the knife should be dipped for two or three minutes in 5 per cent carbolic acid solution, removed and wiped with a towel, and passed through the flame of an alcohol lamp. It is better to inoculate all the least-suspected animals first, and then proceed with those more probably diseased.

In the healthy subject, and in those affected but whose nasal discharge contains no glanders bacilli, no untoward result follows the inoculation and the wound heals quickly. In the diseased subject the wound usually heals in the same manner, although rarely a localized glanderous inflammation may occur. This is followed in from one to five days by a rise of temperature of from 1° to 4°, together with the development of various symptoms of glanders. The

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auto-inoculation, therefore, in cases of occult glanders stimulates the latent form of the disease into activity and thus allows a diagnosis to be made by physical examination.

There are several objections to this method of diagnosis. The main one is the fact that should it result negatively it does not exclude the presence of glanders, as the nasal discharge does not always contain the specific organism even when the animal is affected with the disease. This may be overcome to a certain degree by repeating the inoculation one or more times. A second objection is the fact that the nasal discharge is very liable to contain other virulent organisms besides the *Bacillus mallei*, which may lead to abscess formation. This, however, has been rare, and Haslan reports only two such cases in a series of 150 inoculations. Should it occur, the abscess can be readily opened, and in the great majority of cases will heal readily. A third objection is the fact that hetero-inoculation may accidentally occur. If the knife be sterilized between each inoculation and the operator use ordinary precaution this danger is hardly to be considered. A fourth objection is the fact that many owners when told of the object of the procedure will not allow it to be done.

This method has not been used in the United States. It has been recommended by several writers, including A. J. Haslan, of the British Army Veterinary Corps, while stationed in India. The method undoubtedly is of value in some cases, and is particularly applicable in such situations as the one in which Dr. Haslan was placed. While he was in India mallein was not issued for use among the army horses, and auto-inoculation was the only means at his command for picking out incipient cases.

EXTIRPATION OF THE SUBMAXILLARY GLAND.

This method of diagnosis was advocated by Haubner, Bollinger, and Dieckerhoff. It consists in the surgical removal of an enlarged submaxillary gland in doubtful cases of glanders and the examination of it bacteriologically for the *Bacillus mallei*. Salmon removed the submaxillary glands from three animals which were killed on account of being affected with glanders. In two of these cases the glands were markedly swollen and contained areas of pus. Bacteriological examination, however, failed to disclose the *Bacillus mallei* in a single case, although all of these animals were proved to have glanders. This method for diagnosis requires a surgical operation and would not be allowed by many horse owners. Furthermore, in case of a negative result the horse can not be said to be free from the disease. This method is therefore considered of no practical value.

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DIAGNOSIS BY GUINEA-PIG INOCULATION.

This method was first suggested by Straus, and is often termed "Straus's guinea-pig test for glanders." It is a simple and valuable means of diagnosing those cases of glanders showing farcy buds or a nasal discharge. Although it is usually done at a laboratory, this is not essential, as any veterinarian, with the usual precautions, can apply the test in his office. It is only necessary to have one or two male guinea pigs and an ordinary hypodermic syringe. The nasal discharge is collected on a cotton swab and emulsified with boiled water, so that it can be drawn up into the syringe. The guinea pig is turned over on its back by an assistant, the hair is clipped with scissors from a small area on the abdomen, and the part washed with antiseptic solution. The needle of the syringe is then pushed through the abdominal wall and a few drops of the material injected. The second guinea pig is treated in the same way. Two are inoculated to guard against one dying of peritonitis before the glanders lesions have had time to develop. It is better to allow the animals to live for from three to four days after the inoculation before chloroforming, unless by examining the testicles they are found to be enlarged and the skin covering them hot and reddened, in which case they may be killed at once. The characteristic lesions of glanders are found in the testicle and consist of the thickening of the tunica vaginalis and adhesions between the latter and the testicles. When these are forcibly separated the surface of the testicle is found to contain small white purulent areas. From such a testicle the organisms of glanders can usually be grown in pure culture. Where such changes are found in a guinea pig it is proof that the horse is affected with this disease.

MALLEIN REACTION.

SUBCUTANEOUS TEST.

The first important step toward determining obscure and latent cases of glanders was made by the discovery of mallein. This product was discovered by Kelning, a Russian veterinarian, in 1890. Extensive experiments by Nocard of France and McFadyean of England confirmed the claim of the valuable nature of this diagnostic agent. It is a sterilized filtered extract of the *Bacillus mallei.* The dose of mallein prepared by the Bureau of Animal Industry is 1 cubic centimeter for the average-sized apparently healthy horse. A larger dose, not to exceed 2 cubic centimeters, should be administered to extra heavy, weakened, or aged animals and to those suspected of having glanders. The dose should be reduced accordingly for small animals. Animals exhibiting symptoms of other acute diseases or those with suppurative lesions should not be injected until

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they have recovered. The preferable site for injection is on the side of the neck about the center. where any local swelling is plainly visible. The hair should be clipped from an area about 2 inches in diameter, and the skin thoroughly cleansed with a disinfecting solution, such as 5 per cent carbolic acid. Carefully sterilize the syringe and needle before commencing the injection of each group of animals, and immerse the needle in a disinfecting solution before injecting each animal. It is better to use a separate syringe, needle, and thermometer for animals exhibiting symptoms suspicious of glanders. Carbolized oil, vaseline, or lard should be used to facilitate the insertion of thermometers and also to disinfect them. On the day of injection the temperature of each animal should be recorded not less than three times at intervals of not less than two hours; for instance, at 2, 5, and 8 p. m. A careful clinical examination of each animal should also be made, and to each one some designation should be given by which the animal will be known throughout the test. Mallein may then be injected at 8 or 10 p. m., providing the preliminary temperatures are not abnormal. After injection the temperatures should again be recorded, starting at the expiration of not more than 10 hours, and should be repeated at intervals of approximately 2 hours until the expiration of at least 20 hours from the time of injection, and should be continued over a longer period in the case of an animal with a rising temperature at the twentieth hour, if, at the same time, a local reaction is present. What constitutes a reaction sufficient to warrant condemnation of the animal has been the subject of many articles and prolonged discussion. The Bureau of Animal Industry has adopted the following uniform principles for judging the mallein test:

1. In order that a reaction produced by mallein may be considered positive it should evince the characteristics of a typical reaction; that is, a combination of thermal, local, and general reactions.

2. By a typical reaction is to be understood a gradual rising of temperature of at least 3° F. and to above 104° F., the maximum temperature being sustained in the form of a single or double plateau. It should be accompanied by a local as well as a general reaction.

The local reaction consists of an infiltration at the site of injection, forming a large, abrupt, painful swelling, with radiating lymphatics appearing as raised cords, generally attaining greatest prominence at from 18 to 21 hours after injection. The general reaction is exhibited by a stiffened gait, depression, loss of appetite, and accelerated breathing.

3. The presence of a local reaction, especially when associated with a general reaction, should be regarded as evidence of glanders, even if the thermal reaction be slight or absent.

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4. Animals giving an atypical reaction and those reaching a maximum temperature of 103° F. should be retested after the expiration of not less than 15 days.

In America the most extensive work with malleination has been done by J. G. Rutherford, of Canada. The Canadian department of agriculture is making successful efforts to eradicate glanders from the Dominion, and since March, 1905, it has adopted the policy of compensation and slaughter of all animals which react to mallein, whether they are showing symptoms of the disease of not. Many veterinarians have advanced the idea that repeated malleination has a curative effect on the disease and that ceased reactors may return to work and be stabled with healthy horses without danger of transmitting the disease. These views have been disproved by Rutherford's observation, as he has traced several outbreaks of glanders directly to these ceased reactors.

There is a considerable proportion of glanderous animals in which mallein fails to give a typical reaction, and, on the contrary, a reaction may follow the injection of mallein in the absence of glanders. Thus, mallein is not an entirely reliable diagnostic agent for determining glanders, nor has it ever been considered as efficacious in the detection of this disease as tuberculin is for the diagnosis of tuberculosis. Judging the mallein test is a procedure in the successful performance of which no hard and fast rules can be laid down for adoption in all instances. In the great majority of cases definite and well-marked results are obtained. There are, however, cases in which, after carefully weighing all the points in the case, we are undetermined what course to pursue. In such cases it is best to quarantine the animals and subject them to a subsequent test by applying the complement-fixation method. Various statistics have been gathered from different sources relative to the reliability of the mallein test in the diagnosis of glanders, and from a study of 6,870 recorded cases mallein has been found to give satisfactory results in 89 per cent of the tests applied.

When mallein gives negative reaction in animals which show no clinical indications of glanders, the test may be considered to be efficient as a rule. The greatest number of errors occur in those apparently healthy animals which give positive reactions but which on post-mortem examination are found to harbor parasitic nodules in the liver or lungs rather than glanders nodules.

Schütz has pointed out, and Olt has confirmed the statement, that on post-mortem examination of many cases of reactors nothing but these parasitic nodules are found, which are in fact quite innocent and very often occur in healthy horses. In the handling of those apparently normal animals it would therefore appear advisable to

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consider all nonreactors as healthy, while those which react should be quarantined and subjected to the more accurate complement fixation-agglutination test described on page 364.

OPHTHALMO TEST.

This method of diagnosis has been recommended by various investigators, and variable results have been obtained from this test, but they were not uniformly satisfactory. Nevertheless, Prof. Schnürer,[1] of Vienna, is convinced that with the application of this test by the method recommended by him the disease can be diagnosed in most cases, particularly if in the doubtful cases the agglutination test is employed as an adjunct. The method which is followed in Austria, and which constitutes the official test of that country, is carried out as follows:

The test is made by practitioners. They are furnished with the mallein from the central laboratory at Vienna. Pasteur's "mallein brute" is used, of which 0.75 c. c. are used for 10 horses. The mallein is applied to the eye with a camel's-hair brush in the following way: The eyelids are opened with the index finger and the thumb, as is customary when examining the conjunctiva of the eye. Then the camel's-hair brush, which has been submerged in the mallein, is drawn once forward and again backward over the eye. Only one eye is used, the other serving as a control. Immediately after the application of the mallein to the eye in most of the animals lacrimation, increased reddening, and twinkling of the eye appear; these primary reactions are not specific and disappear in the following few hours. The specific reaction commences as a rule 5 or 6 hours after the application of the test and lasts from 36 to 48 hours, occasionally even longer. It consists in a suppurative conjunctivitis, with reddening, swelling, and suppurative secretions. Of these signs only a suppurative secretion should be taken into consideration. The results are interpreted as follows: (1) The reaction is positive if a suppurative secretion is observed in varying quantities. If the secretion is present only in a small quantity, it is principally visible on the inner canthus of the eye. (2) The reaction is negative in the absence of any secretion. (3) The reaction is doubtful when there is present a slimy secretion or lacrimation after 24 hours.

The judgment should be made not earlier than 12 hours and not later than 24 hours after the application of the test. The examination should be made in a good light. A positive result indicates with certainty the presence of glanders; negative results, however, should not eliminate the possibility of the presence of the disease, and only a

[1] Schnürer, J. Die Diagnose der ansteckenden Tierkrankheiten mittels der neuen Immunitäts Reaktionen. IX. International tierärzt. Kongress im Haag., 1909.

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repeated negative test after three weeks excludes suspicion of the disease.

Generally the positive ophthalmo reactions are not accompanied by fever or systemic disturbances. Occasionally, however, affected horses are hypersensitive, so that often a trace of mallein which enters the circulation produces fever. Accordingly, it is advisable to accompany the ophthalmo reaction with temperature measurements. For this purpose the temperature should be taken twice, the first time when the eye test is being made and the second time when it is judged. In a doubtful eye reaction where there is an increasing temperature over 101.5° F., the test should be considered positive if the animal had a normal temperature at the time the test was made.

The following principles should be considered in the application of ophthalmo tests:

1. The test should not be undertaken in the presence of a conjunctival catarrh.
2. The removal of the suppurative secretion (by the stable attendant or by the animals licking each other, etc.) may obliterate the indication of a positive result.
3. Positive reactions may be brought on by irritation of the eye.
4. In very rare cases the ophthalmo reaction runs atypically; it is either abortive—that is, it appears very quickly and disappears in a few hours, or it may appear delayed—that is, after 24 hours; both of these reactions should be considered as doubtful.
5. Very rarely it may occur that both eyes react.
6. Between the intensity of the reaction and the degree of the pathological changes there exists no definite relation.

The experience in this country with the ophthalmo reaction for the diagnosis of glanders is very slight. From the limited number of cases which have been tested by this method it is almost impossible to establish the reliability of the test, and accordingly no recommendations can be made as to its effectiveness. One of the writers personally witnessed the application of this test on a glandered horse in the manner described above, and the inflammatory secretion of the reaction appeared so pronounced in the eye that it could be seen from a distance of 20 yards.

CUTANEOUS TESTS.

Since the application of this method of testing by Von Pirquet in 1907 with tuberculin for the diagnosis of tuberculosis in persons, the cutaneous test, as well as the intradermal test, has also been applied to some extent in the diagnosis of glanders. The results, however, which were obtained from these methods of testing were not sufficient to establish their diagnostic value. The most favorable results

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were obtained by Schnürer,[1] who claims some value in these methods of diagnosis. For the cutaneous testing concentrated mallein is used, and the application is carried out by superficial scarification of the skin, after which the concentrated mallein is applied to the scarified surface. The hair is shaved on the side of the neck for a length of about 10 centimeters and a width of 5 centimeters. Then, with the aid of an inoculation vaccination lancet three superficial crisscross scarifications are made in equidistant locations. The form of each scarification is #. The first and the third of these scarified areas is painted over with the mallein, while the middle one serves as a control. The reaction commences 6 hours after the application, continues for 24 hours and then disappears gradually. The extension and thickening of the skin varies in the reacting animals 15–50 by 20–55 centimeters, while the thickening may extend from 1 to 2 centimeters. Of course the middle scarification should show no indication of reaction, but serves as the control.

The intradermal reaction has also been applied, but the results were also more or less unsatisfactory. The edematous swelling which develops as a result of the injection is not always sufficiently characteristic to establish the presence or absence of glanders in an animal. This may be also carried out on the side of the neck, about 0.1 c. c. of the crude mallein being used and injected into the skin proper.

SERUM AGGLUTINATION REACTION.

This is one of the later additions to our resources in diagnosing glanders, and with the improvement herein suggested it promises to prove one of the most valuable adjuncts. It was first suggested by McFadyean in 1896, after this investigator had observed the value of Widal's typhoid fever agglutination test. Later, extensive work was done on this subject by Schütz and Miessner, and their results were published in 1905. They used the dead cultures of *Bacillus mallei*, with the sediment macroscopic method, while McFadyean had applied the hanging-drop microscopic method. Schütz and Miessner's method has been generally adopted, and with the improvement suggested by them the execution of this test is greatly simplified and requires a considerably less time than any other method known for the diagnosis of glanders.

In this country the most extensive trial of diagnosis by agglutination has been conducted by V. A. Moore[2] and his assistants, at Ithaca, N. Y. The method pursued by Moore was based on the technique originally suggested by Schütz and Miessner, but the method as it is now practiced in Germany has many advantages.

[1] Schnürer, J. Die Diagnose der ansteckenden Tierkrankheiten mittels der neuen Immunitäts Reaktionen. IX. International tierärzt. Kongress im Haag., 1909.

[2] Moore, Taylor, and Giltner. The agglutination method for the diagnosis of glanders. American Veterinary Review, vol. 30. 1906.

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In using this method of diagnosis it is of primary importance to have a suitable culture of *Bacillus mallei.* All cultures of this organism are not susceptible to the specific glanders agglutins which are present in the serum of glandered horses. When a suitable culture is obtained, which is usually accomplished after testing three or four cultures of the organism from different sources, it is kept in stock in the laboratory, and from it the test fluid is made. When a supply of the test fluid is about to be made the organism is inoculated into the abdominal cavity of a male guinea pig. The guinea pig may be killed as soon as the swelling of the testicles is observed, or may be allowed to die naturally. A culture is then made from the testicles on acid glycerin-agar. This constitutes the first generation of the culture after it has been passed through the guinea pig, and it is essential to have the culture pure and uncontaminated with any other organism. When this culture has made a good growth, which requires about 48 hours, it is transferred to a number of glycerin-agar tubes, or, preferably, to Kolle flasks containing glycerin-agar medium, the number of such inoculations depending upon the quantity of test fluid desired. The preference for the Kolle flasks is given on account of the surface of the medium being much larger than in tubes, and therefore a greater quantity of bacilli can be obtained from them. After inoculating the medium with glanders bacilli, the flasks are placed in the incubator, and after 24 hours it is advisable to allow the condensation water in the culture to run over the surface of the medium. This practice will insure a luxuriant growth of the organism. After another 24 or 28 hours in the incubator the surface of the medium contains usually a good growth of glanders bacilli.

The flasks or tubes are then taken from the incubator and placed in a thermostat, where they are heated for two hours at 60° C. in order to render the bacilli inactive. Then the cultures are washed off with a physiological salt solution, to which 0.5 per cent carbolic acid solution has been added. Fifty to 100 c. c. are used for each flask. The fluid is then filtered through ordinary filter paper.

A sample of the old emulsion, which has been previously titrated and tested, is then taken, and by gradual dilutions of the new test fluid an optical similarity of the two solutions is attempted. The precise optical similarity is established in the following manner: Two beakers are taken, one being marked *O*, the other *N*. They are filled to a height of 2.5 centimeters, the beaker marked *O* with the old and the one marked *N* with the new test fluid. The beakers containing the test fluid are placed in an ice chest for several days. They are then taken out and placed on printed paper, preferably on engraved print, and by looking from above through the fluid the appearance of the printed matter indicates the density of the test

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fluids. If it is found that the new test fluid is denser than the old, it is diluted with carbolized salt solution, and this is repeated until there is a uniform density established in the two dilutions. The dilutions should be made very gradually in order not to get the new solution too thin. In that case it can be thickened only by the addition of bacteria.

Three sera of known agglutination power are then taken, and each is tested with both test fluids. In case the agglutination of the new fluid shows the same result as the old one, which is also confirmed by the known agglutination power of the tested sera, then it is proved that the new test fluid is of proper strength. Before these serometric tests are made it is advisable to keep the fluid for several days in the ice chest. These test fluids keep well for about two months at a temperature of from 4° to 6° C.

With the test fluids prepared and titrated, the test can now be undertaken. This is a simple procedure. The blood is taken from the jugular vein of the horse by means of a small trocar and cannula, and the serum is allowed to separate.

The test fluid is distributed into four tubes containing 3 c. c. each. Sufficient serum is then added to make the dilutions 1 to 200, 1 to 500, 1 to 800, and 1 to 1,200, respectively. They are then set aside in the incubator and examined by the old method at the end of 24, 48, and 72 hours for the macroscopic evidence of agglutination.

In the laboratory the serum is diluted with physiological salt solution and measured by means of a finely graduated pipette directly into the test tubes.

This method of agglutination testing has recently been improved by Miessner,[1] Pfeiler,[2] and Müller,[3] and it assures considerable saving of time in the diagnosis. The preparation of the test fluid as well as the titration is made as described above, while the test proper is executed in the following way:

The pipettes used are of 1 c. c. capacity graduated into hundredths, 12 c. c. pipettes graduated into twentieths, and 25 c. c. pipettes graduated into tenths. Test-tube stands holding 12 tubes with conical shaped holes at the bottom are used. The tubes should be such as may be used for centrifugalization. Nine tubes are placed in the stand marked with the number of dilutions the respective tubes contain. The suspected serum is diluted with carbolized salt solution in the proportion of 1 to 40 (0.5 c c. serum to 19.5 c. c. carbolized salt

[1] Miessner. Die Schnellagglutination und ihre Verwandung bei der Serodiagnose des Rotzes. Centralblatt für Bakteriologie. Abt. 1, Orig., Band 48. 1908.

[2] Pfeiler, W. Über die Serodiagnose der Rotzkrankheit und die Beschleunigung der Agglutination der Rotzbazillen durch Zentrifugieren. Archiv für Wissenschaftliche und Praktische Tierheilkunde. Band 34. 1908.

[3] Müller, M. Beiträge zur Agglutinationstechnik beim Rotz. Berliner Tierärztliche Wochenschrift. 1908.

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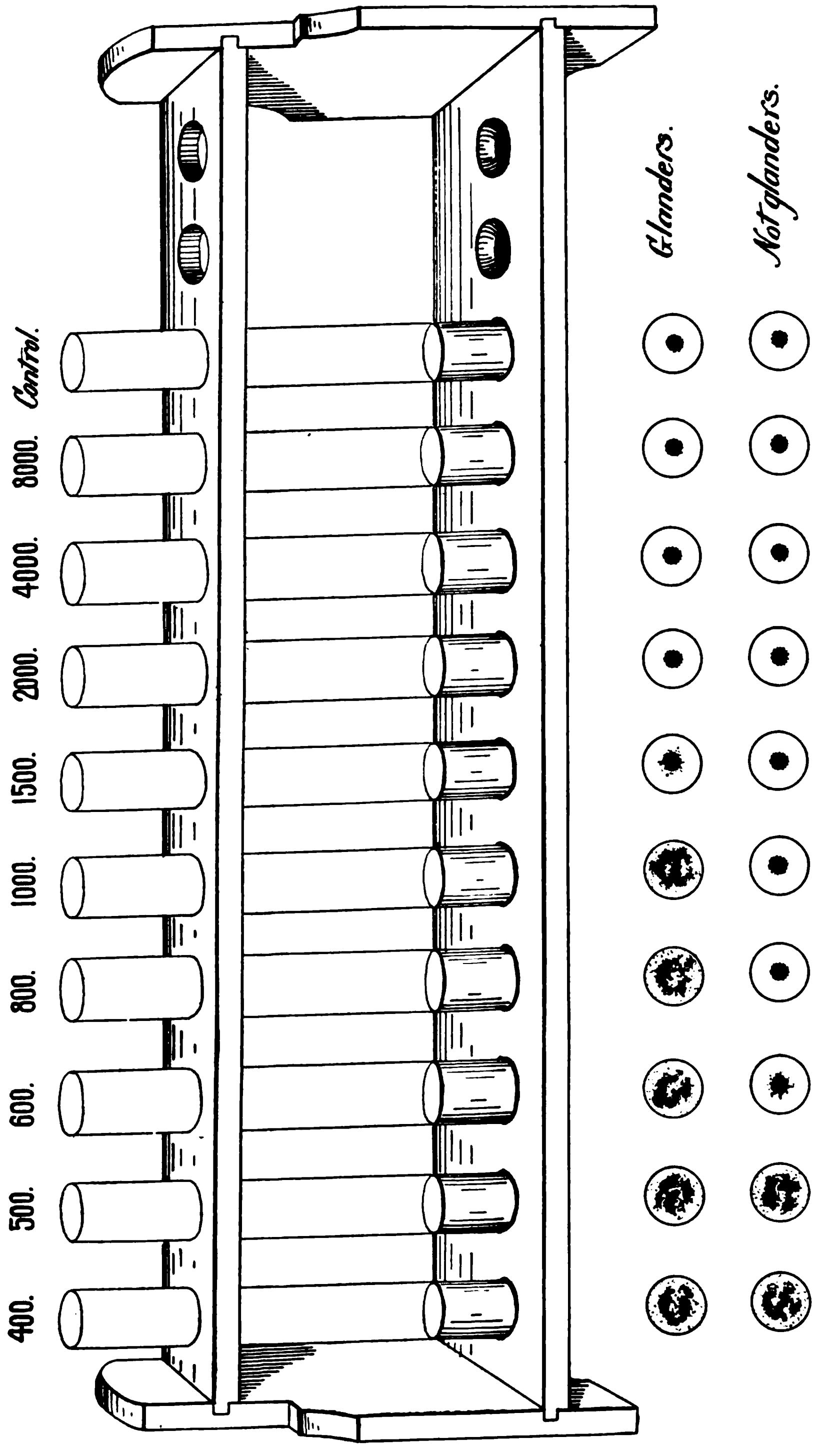

TYPES OF AGGLUTINATION IN THE DIAGNOSIS OF GLANDERS.

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solution). This constitutes the basic dilution, and from this all the dilutions are made.

From the 1 to 40 basic dilution some of the fluid is drawn up in a pipette graduated into hundredths and the test tubes are successively filled with quantities from this pipette, as indicated by the table below. Then to each tube 2 c. c. of test fluid (bacilli emulsion) are added. The quantity of basic dilution required to make the individual serum dilutions is represented by the following:

Dilution of 1 to 300 equals 0.24 c. c. of basic dilution.
Dilution of 1 to 400 equals 0.2 c. c. of basic dilution.
Dilution of 1 to 500 equals 0.16 c. c. of basic dilution.
Dilution of 1 to 600 equals 0.13 c. c. of basic dilution.
Dilution of 1 to 800 equals 0.1 c. c. of basic dilution.
Dilution of 1 to 1,000 equals 0.08 c. c. of basic dilution.
Dilution of 1 to 1,500 equals 0.06 c. c. of basic dilution.
Dilution of 1 to 2,000 equals 0.04 c. c. of basic dilution.
Dilution of 1 to 4,000 equals 0.02 c. c. of basic dilution.
Dilution of 1 to 8,000 equals 0.01 c. c. of basic dilution.

The tubes are then centrifugalized for 10 minutes in a centrifuge making from 1,500 to 1,600 revolutions a minute. After removal they are allowed to stand for 1½ hours, when the results are read. These results can be perfectly seen by taking the stand containing the tubes and holding it up toward the light of the window to see the bottom of the test tubes. (See Plate XXVII.) The appearance of an irregular, veil-like clumping at the bottom of the tube with a clearing of the upper part of the fluid indicates an agglutination, while the collection of a dense white precipitation at the bottom of the tube and a cloudiness of the upper part of the fluid indicate failure of agglutination.

In carrying out this method of testing in the regular routine of work it is not necessary to employ all of the nine tubes for the test, as four tubes of the dilutions of 1 to 400, 600, 800, and 1,000 are sufficient for ordinary testing. Should the agglutination prove to be higher than 1,000, an additional test to establish the maximum agglutinating power of the serum can be undertaken. By this procedure considerable time can be saved in the execution of the tests.

The serum of most horses free of glanders agglutinates up to the value of 1 to 400, while the serum of glandered horses, as a rule, agglutinates over 1 to 600. On the other hand, experience has proved that horses affected with chronic glanders give occasionally a very low agglutinating value, which in some cases is often lower than that of normal horse blood serum. From this condition it appears evident that in the presence of chronic glanders the disease could be determined in an animal only by repeated tests, and therefore in such cases the diagnosis is possible only from the fluctuation of the agglutination value, as it is a well-known fact that this value is stationary in normal horses.

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Sometimes normal horse serum will agglutinate in the value of 1 to 800. However, agglutination hardly occurs above this value in horses free of glanders.

After extensive experience with the agglutination test, Schütz and Miessner[1] established the following rules to serve as guides in judging the results of the agglutination test:

1. All animals suspected of being affected with glanders should be subjected to the agglutination test.
2. All those horses should be destroyed in which the blood shows an agglutination of 1,000 and over.
3. All horses should be destroyed in which the blood shows an agglutinating value of from 500 to 800 and which at the same time show clinical manifestations of glanders.
4. All other horses in which the blood shows an agglutinating value from 500 to 800 should be isolated and destroyed only in case on the second examination the agglutinating value changes.
5. All horses in which the blood shows an agglutinating value of 500 to 800 should be considered free of glanders when the agglutinating value remains unchanged on the second examination.
6. If the presence of the disease has been established in a stable, the blood of all horses should be retested at the end of the third week.

Malleinization of the horses shortly before the blood is taken for the agglutination test influences the results of the test often to a great extent, and therefore it is absolutely essential not to attempt to make the agglutination test in cases where the mallein test has just been made. Ten days to two weeks should elapse before the blood should be taken for the agglutination test from horses which have been tested with mallein.

This method of diagnosis has had considerable trial in the different countries of Europe, and particularly in Austria and Germany. The results obtained proved that the test gave excellent results in acute cases of glanders, and accordingly it serves as a splendid adjunct to the complement-fixation test, which always gives good results in chronic cases.

In this country the agglutination test has been used only to a limited extent, and therefore no bold claims can be made for it. However, its adoption by some of the European governments indicates that it is a valuable means for diagnosing glanders, particularly if adopted as an adjunct to the complement-fixation test.

PRECIPITATION REACTION.

This method of diagnosis was discovered by Kraus and has been given considerable attention in the diagnosis of glanders. It is based upon the fact that when blood serum comes in contact with different forms of extracts of glanders bacilli the precipitins or

[1] Schütz and Miessner. Zur Lerodiagnose der Rotzkrankheit. Archiv für Wissenschaftliche und Praktische Tierheilkunde. Band 31, 1905.

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receptors which are formed in the blood of affected animals from the time the infection first occurs are bound to the bodies in the bacillary extract, producing a precipitation which is manifested by cloudiness at the point of contact of the two fluids.

This method was first applied to glanders by Dediulin in 1900, but the results were not entirely satisfactory. Wladimiroff mixed the serum of glandered and healthy horses with a filtrate of glanders cultures in proportions of 1 to 2 and 1 to 40. The results were not uniform, and his method of application could not be well utilized for diagnostic purposes. The results of Shirnoff were similar. However, he found that by centrifugalizing the mixture the fluid of healthy horses cleared entirely, whereas the fluid containing the serum of glandered horses showed a certain opalescence.

The application of this method, however, appeared to give far more satisfactory results when employed in the manner first described by Pfeiler[1] and Miessner.[2] These two investigators, who evidently worked independently on this method of diagnosis, adopted a technique in which the interfering action of the normal precipitins in the serum was excluded. This is accomplished by applying the solutions in such a manner that a contact layer of the solutions will result.

The method recommended by Pfeiler is somewhat more complicated than the method of Miessner, and it is carried out in the following manner:

About 0.5 c. c. of serum of the suspected horse is drawn off by a pipette and allowed to run down into an Uhlenhuth tube. It is advisable to adopt a method by which the serum is run into the tube at a certain place, preferably on the left side of the tube. By this procedure a road is made by the fluid in the tube. Then the antigen (extract of glanders bacilli) is drawn into a pipette. First, 1 drop is allowed to run into the tube at about the same place where the serum has run down. Then 0.3 c. c. of the extract is allowed to run down on the side of the tube. This procedure is followed in order to insure that the first drop of antigen forms a layer on the surface of the serum, and the antigen added will then collect on top of the fluid without disturbing the point of contact. If a number of tubes are undertaken, all the tubes should receive first the serum, and then by the method indicated above the antigen is added to each tube. The tubes are kept at room temperature, and the results are read not later than one hour. Strongly precipitating sera react in 1 to 10 minutes. The precipitation ring is manifested at the point of con-

[1] Pfeiler, Willy. Die Ermittelung der Rotzkrankheit durch die Präzipitationsmethode. Archiv für Wissenschaftliche und Praktische Tierheilkunde. Band 35, Heft 4/5, pp. 323–337. June 24, 1909.

[2] Miessner. Die Verwendung der Präzipitation in Form der Schichtungsmethode zur Diagnostik der Rotzkrankheit. Centralblatt für Bakteriologie, 1909, Orig. Band 51.

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tact of two solutions in the form of an opaque zone, the density and thickness of which depend on the amount of precipitins present in the examined serum.

The extract (antigen) which is used in the precipitation test is identical with the extract employed in the complement-fixation test. Before the extract is adapted for this testing it is necessary to titrate it. Of the concentrated extract dilutions are made with salt solution in proportions of 1 to 1, 1 to 2, 1 to 3, 1 to 4, 1 to 5, 1 to 6, 1 to 8, 1 to 10, 1 to 12, 1 to 15, and 1 to 20. Then 6 sera of non-glandered horses and 6 sera of glandered horses are taken and tested with the various dilutions of the extract. For future testing the dilution of the extract is used which produces the most marked precipitation in the glandered sera and which at the same time gives no precipitation in the sera from horses free of glanders.

The method of Miessner is also carried out in Uhlenhuth tubes in which about 0.5 c. c. of undiluted serum is placed. He employs as antigen mallein which is marketed under the name of "Malleinum siccum Foth." The antigen is carefully allowed to run into the tube in order to have a distinct point of contact develop between the serum and the mallein. He then places the racks containing the tubes into incubators at 37° C. for two hours, after which time the results are read. The reaction is the same as in the method of Pfeiler.

A modification of the precipitation test has been recommended recently by Konew.[1] He prefers the use as an antigen of a fluid which he named "mallease" and which represents a filtrate of glanders bacilli dissolved in antiformin.

This solution of the glanders micro-organism is prepared by dissolving the growth which occurs on a 2-day-old agar culture with an 8 per cent antiformin solution by using about 10 cubic centimeters of the latter to each agar culture. Antiformin is the patented name of a disinfectant made by adding sodium hydrate to a solution of sodium hypochlorid, and is on the market at 60 cents a pint. Its activity seems to be due to an intense oxidation. This solution of antiformin has recently been attracting the attention of those bacteriologists who are interested in sputa examinations on account of its ability to dissolve various forms of bacteria generally found in the sputum without affecting in any way the bacillus of tuberculosis, thereby permitting the latter to be more readily detected on microscopic examination. It has this same ability to dissolve the bacillus mallei, and in two hours at room temperature the washed culture previously referred to is completely dissolved by the solution of antiformin. If the culture dissolves quite rapidly, Konew adds to this

[1] Konew, D. Präzipitationsreaktion als diagnostische Methode beim Rotz. Vorläufige Mitteilung. Centralblatt für Bakteriologie. Abt. 1, Orig., Band 55, Heft 3, pp. 251–253. July 9, 1910.

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solution another washed culture of greater density in order to obtain as a final result a saturated or concentrated antiformin solution of glanders bacilli. This solution is at first strongly alkaline, but is neutralized by means of a 5 per cent solution of sulphuric acid. The solution is then filtered, first by ordinary filter paper and later by the Berkefeld filter, in order that the fluid will be homogeneous without any undissolved bacilli being present. This fluid constitutes the one component part of the precipitation reaction, and as a name to distinguish it from the other soluble albumens Konew has termed it "mallease," which is analogous to the terms tuberculase, pyocyanase, etc.

According to its discoverer, the precipitation reaction is carried out in the following manner:

The blood taken from the jugular of the horse to be examined is collected in a glass container and then allowed to remain at room or incubator temperature. The separated serum which is thus obtained serves as the second necessary fluid for the precipitation reaction. In order to produce the reaction 1 cubic centimeter of the mallease is poured into a glass test tube of 3 to 4 millimeters in diameter and 15 centimeters long so that the liquid in the tube is about 3 centimeters in height. Then about the same quantity of the blood serum from the suspected horse is taken in a Pasteur pipette which is introduced into the tube containing the mallease in such a manner that the point of the Pasteur pipette reaches the bottom of the tube. Not until then is the serum allowed to pour very slowly under the mallease. Inasmuch as the serum has a higher specific gravity, it remains on the bottom while the mallease is forced up. The free end of the pipette is then covered with the finger and the pipette is carefully taken out so that the serum is not mixed with the mallease. Such a mixing should also be avoided during the introduction of the pipette into the serum. The two solutions must only come in contact at one point and then the reaction will be very marked.

In case of a positive reaction—that is, when the serum is obtained from a horse affected with glanders—a ring of white cloudiness develops at the point of contact of the two clear solutions, as a result of the precipitin formation, which is particularly marked in good daylight when the tube is placed in front of a window against some dark object. According to the duration of the disease, the white ring develops at various times and in varying intensity. In severe and chronic cases of glanders the serum produces the ring immediately; in slight affections when the lesions are not very marked in the animal, the precipitation reaction appears only in 5 to 15 minutes.

This white cloudy zone is somewhat suggestive of the white ring formed by the presence of albumen in the nitric-acid test of urine. (See Pl. XXVIII, fig. 1.)

Based on his results, Konew drew the following conclusions:

1. By using the concentrated solution of glanders bacilli (mallease), the precipitation reaction can be applied as a diagnostic method even in the earliest stages of glanders.

2. As a result of the simple technique and the short time required for examination (about one hour), the precipitation reaction should be preferred to any other method of diagnosis.

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3. Blood from the horses to be examined should be taken before the injection of mallein.

4. The solution of mallease must be titrated in accordance with other standard serums before they are given out in practice, and therefore they should only be prepared in bacteriological laboratories.

COMPLEMENT-FIXATION TEST.

In 1909 Shütz and Schubert[1] published the results of their important work on the application of the method of complement fixation for the diagnosis of glanders. And since their experiments were followed by splendid results, exceeding by far the results obtained from either the mallein or the agglutination test, they recommended that this method of diagnosis in combination with the agglutination test be taken as the official test in Germany. This method, overcoming as it does the disadvantages of the mallein and agglutination tests, constitutes without doubt the most reliable method for the diagnosis of glanders which we have at our command at the present time. The complement-fixation test is, in fact, the most definite method known for determining specific infections and is as nearly perfect as a biological test can be. It has recently been thoroughly studied by this bureau and has given excellent results.[2]

Meyer[3] has also published a recent article on the value of this test in which he concludes that occult glanders may be more readily diagnosed by the complement-agglutination method than by the mallein test.

The principle of this test is presented in the phenomenon of hemolysis, which was first discovered and studied by Bordet and Gengou, and extended by Ehrlich, Morgenroth, and Sachs. It is called the complement-fixation test on account of the fact that the complement has been fixed by the combination of antigen with antibody and thus prevented from participating in the hemolytic process in which it is essential in order for hemolysis to take place. By this method even small quantities of glanders amboceptors (antibodies) can be demonstrated in a serum.

The presence of an infectious principle in the organism of an animal or a man has a stimulating effect on the production of antibodies (immune bodies). If a serum containing such immune bodies is inactivated and brought into contact with the antigen in the presence of complement, the complement will become firmly fixed by the combined immune body and antigen. (See Pl. XXVIII,

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[1] Schütz and Schubert. Die Ermittelung der Rotzkrankheit mit Hilfe der Komplementablenkungsmethode. Archiv für Wissenschaftliche und Praktische Tierheilkunde. Band 35, Heft 1/2, pp. 44–83. 1909.

[2] Mohler, John R., and Eichhorn, Adolph. The Diagnosis of Glanders by Complement Fixation. U. S. Department of Agriculture, Bureau of Animal Industry, Bulletin 136. 1911.

[3] Meyer, Karl F. Sero Diagnosis of Glanders. American Veterinary Review, vol. 39, Nos. 2 and 3. 1911.

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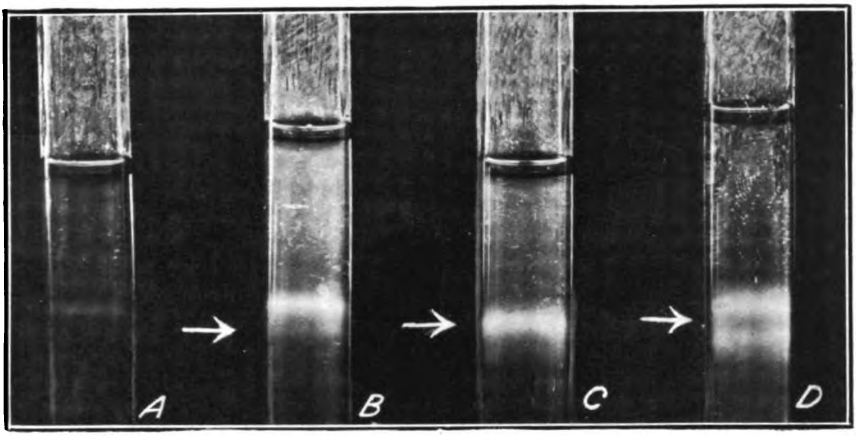

FIG. 1.—PRECIPITATION REACTION FOR GLANDERS.

A. Negative reaction; control test with serum from healthy horse.
B. Positive reaction; serum obtained from an occult case of glanders. (Note cloudy ring at point of contact of two fluids, indicated by arrow.)
C. Positive reaction; serum obtained from case of nasal glanders.
D. Positive reaction; serum obtained from horse with chronic farcy.

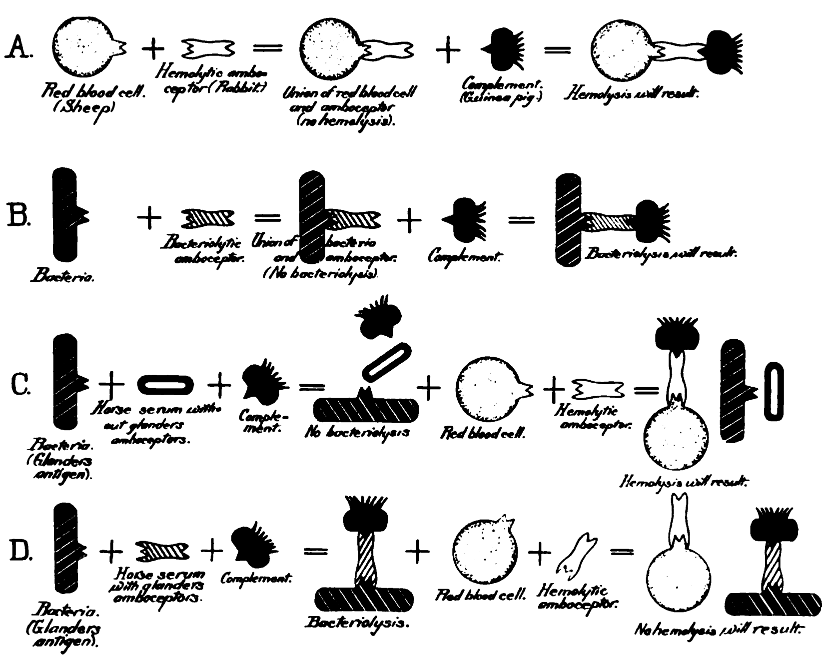

FIG. 2.—DIAGRAMMATIC REPRESENTATION OF COMPLEMENT FIXATION.

A. Hemolytic system.
B. Bacteriolytic system.
C. Negative reaction with normal horse serum.
D. Positive reaction with glandered horse serum.

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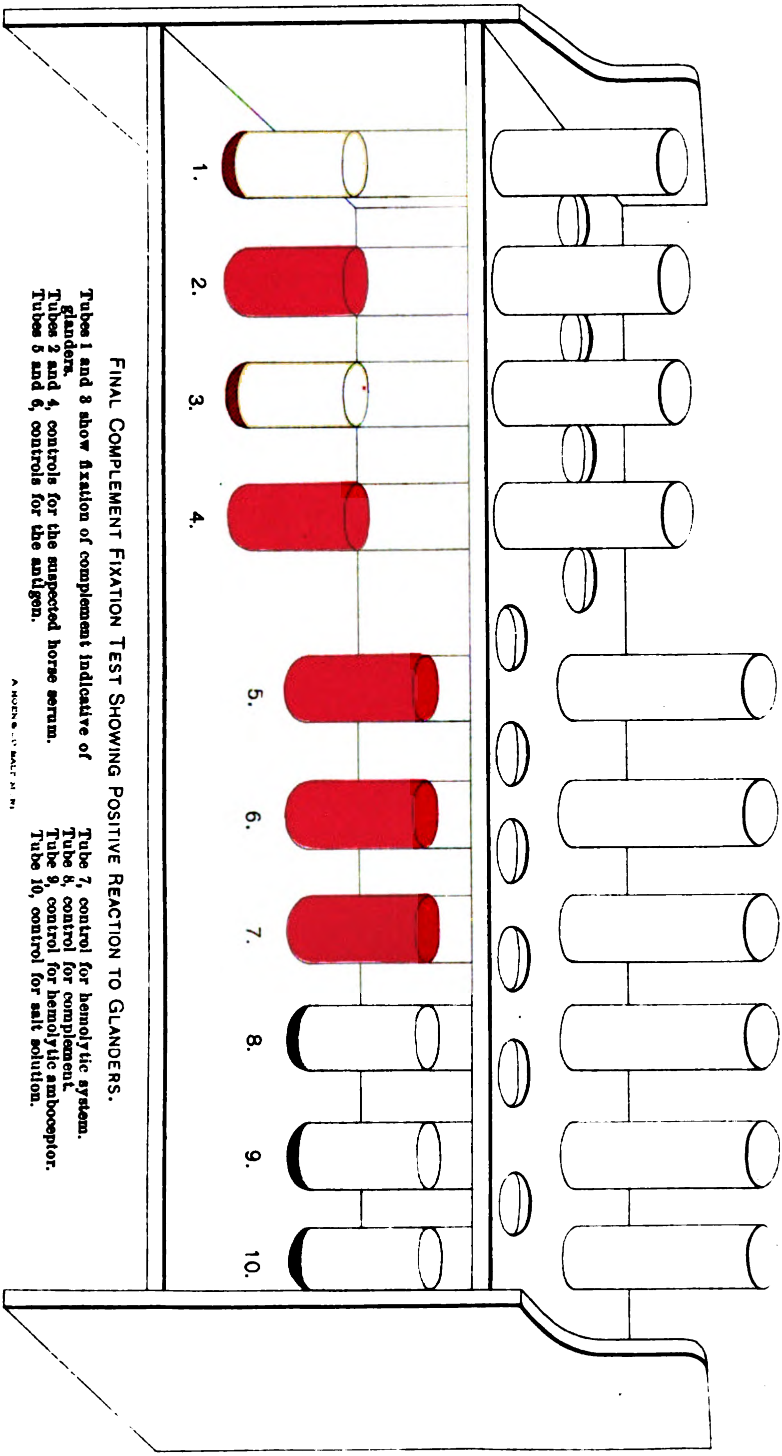

FINAL COMPLEMENT FIXATION TEST SHOWING POSITIVE REACTION TO GLANDERS.

Tubes 1 and 3 show fixation of complement indicative of glanders.
Tubes 2 and 4, controls for the suspected horse serum.
Tubes 5 and 6, controls for the antigen.
Tube 7, control for hemolytic system.
Tube 8, control for complement.
Tube 9, control for hemolytic amboceptor.
Tube 10, control for salt solution.

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fig. 2, *B.*) Thus, anchoring takes places between the antigen and the antibody in which the complement becomes fixed. This anchoring is thoroughly established when the mixture is placed in an incubator for one hour. The addition of the hemolytic amboceptor and blood corpuscles to such an anchored antigen and immune body will have no effect. (See Pl. XXVIII, fig. 2, *D.*) Thus no hemolysis will take place, inasmuch as the complement has been fixed by the immune body and the antigen, thereby leaving the hemolytic system incomplete. On the other hand, if the inactivated serum contains no immune bodies, there would be no substance in the serum to anchor the antigen. As a result, therefore, no fixation of complement will occur, this being left free, and on addition of hemolytic amboceptor and blood corpuscles hemolysis will now take place. (See Pl. XXVIII, fig. 2, *C.*) Neither the antigen nor the antibody alone can fix the complement and thereby influence hemolysis when the hemolytic amboceptor and blood corpuscles are added. However, in combination the fixation will invariably take place, and on the addition of the hemolytic amboceptor and blood corpuscles hemolysis will not be produced.

Since the discovery of this phenomenon it has been utilized extensively in serum diagnosis, but probably its greatest value has been obtained from the Wassermann reaction for the diagnosis of syphilis. It has also been employed in other diseases with more or less satisfaction, and its great field in bacteriological investigations has not yet been exhausted for the practical diagnosis and determination of immune bodies in serum. In veterinary practice complement fixation is now gradually becoming used for the diagnosis of glanders. This method of diagnosing glanders has given the most favorable results in Germany, and constitutes at the present time the official test for Prussia and other parts of Germany. It has also been used in the diagnosis of other diseases of animals, but not with such success as in glanders.

The presence of the specific immune bodies (bacteriolytic amboceptors) in the serum of glandered horses brings about the fixation of the complement when the antigen in the form of glanders bacilli extract is added to the hemolytic system. The serum of glandered horses, therefore, contains antibodies (immune bodies) against glanders bacilli, which are specific only for the glanders bacilli and for no other infection. The complement fixation accordingly represents a specific test, as only in the presence of the glanderous immune bodies and glanderous antigen will the reaction take place. If, instead of the glanderous immune bodies, other antibodies of another infectious disease be present in the blood serum, they will exert no effect whatsoever on the glanderous antigen; and, on the other hand, if serum containing glanderous immune bodies is brought in contact

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with an antigen of another infectious disease it will also have no effect on the reaction. By this fixation of the complement the hemolytic system is left incomplete, and as a result no hemolysis will take place. This fixation of the complement by the antigen and immune bodies of glanders in the horse serum constitutes the diagnostic test for this disease.

In the application of the test it is necessary to have substances constituting the hemolytic system, which are the washed blood corpuscles of a sheep, the hemolytic amboceptor (rabbit serum), and complement (normal guinea pig serum).

There are also used, besides the hemolytic system, the serum of the horse to be examined and antigen (extract of glanders bacilli). The preparation of these various substances and the technique of their application is explicitly presented in Bureau of Animal Industry Bulletin 136, previously mentioned.

The results of the tests are manifested in most instances by a distinct reaction which takes place in the test tubes.

We may thus obtain in these tubes either complete hemolysis, incomplete hemolysis, or no hemolysis whatsoever. The fixation of the complement is manifested by the absence of hemolysis, and therefore we have a settling of the blood corpuscles with the watery clear fluid above. Such a result indicates without doubt the presence of glanders. (See Pl. XXIX.) On the other hand, if the tubes show complete hemolysis, the absence of glanders is thereby indicated. In the presence of glanders a fixation of the complement takes place, as a result of anchoring to the immune bodies and antigen (see Pl. XXVIII, fig. 2, *D*), while in the absence of glanders, there being no immune bodies present, the complement is used up in the phenomenon of hemolysis. (See Pl. XXVIII, fig. 2, *C*.)

Then, again, we may have cases in which the fixation of the complement is incomplete; that is, there is a settling of corpuscles in the bottom of the test tube, but the fluid shows traces of hemolysis. It does not show the characteristic saturated color of hemolysis, but only a tingeing with the hemoglobin. This is termed an almost complete fixation, and also indicates the presence of glanders. The presence of the characteristic color in the fluid and a very slight deposit of corpuscles on the bottom should not be taken as an indication of an infection, as such a condition may be brought on by various causes, and particularly so by the presence of nonspecific substances in the serum of the horse, which may cause a very slight checking of the hemolysis. But all cases where the results show a fixation of the complement (no hemolysis) or almost complete fixation (slight tingeing of the fluid above the settled blood corpuscles) indicate the presence of glanders.

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The results of the complement-fixation test should be interpreted as follows:

1. Horses in which the serum produces a complete fixation of the complement in the quantities of 0.1 and 0.2 c. c. should be considered as glandered.

2. Horses in which the serum gives a complete fixation in the quantity of 0.2 c. c. and an incomplete fixation in the quantity of 0.1 c. c. should likewise be considered as glandered.

3. Horses in which the serum produces an incomplete fixation of the complement in the quantities of 0.1 and 0.2 c. c. should also be considered as glandered.

4. Horses in which the serum shows no fixation of the complement in either tube should be considered free of glanders.

In order to reduce the possibility of error to a minimum the agglutination test may be applied to the latter cases, and if this shows a value of 1 to 1,000 or over, the animal should be considered as glandered. However, such cases are extremely rare.

Since this method of diagnosis for glanders was inaugurated in this laboratory large numbers of horses and mules have been examined in the District of Columbia, as well as the blood of animals from other parts of the United States. Many of the horses examined had clinical cases of glanders, while others were selected because they were reactors to the mallein test, some typically, and others atypically. A large proportion of the cases, however, were exposed or "contact" horses. From the number of tests already made—about 1,540—the results indicate that in the complement fixation we have a method which in accuracy is equal to the tuberculin test for the diagnosis of tuberculosis in cattle. The results of the tests thus far conducted show that at least 97 per cent of the cases of glanderous affections can be determined by the complement-fixation method. Furthermore, the affected horses in which a negative or an atypical reaction occurs are as a rule either very old chronic cases of glanders, or those fresh cases of infection tested during the period of incubation. According to Hutyra and Marek [1] the diagnosis of glanders by the complement-fixation test has already given such accurate results that it may be considered as the best method for the determination of this disease at the present time.

Among the horses tested by complement fixation there were a number of animals which gave an atypical reaction to the mallein test, but on the complement-fixation test proved either absolutely positive or negative. Of these horses those which gave a positive reaction and were killed proved to be glandered. The table following shows the comparative results obtained with the mallein and complement-fixation tests.

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[1] Spezielle Pathologie und Therapie der Haustiere. Third edition, Band 1, p. 717, 1910.

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Comparative results with mallein and complement-fixation tests.

Locality.	Positive to mallein test.					Negative to mallein test.			Atypical reaction to mallein test.					Total animals.
	Total number of tests.	Response to complement-fixation test.		Post-mortem.		Total number of tests.	Response to complement-fixation test.		Total number of tests.	Response to complement-fixation test.		Post-mortem.		
		Positive.	Negative.	Positive.	Negative.		Positive.	Negative.		Positive.	Negative.	Positive.	Negative.	
California	6	4	2											6
Canada	1		1											1
Connecticut	9	8	1	3					1	1		1		10
Florida	9	5	4			9	8	1	6		6			24
Illinois	6	4	2						4	4				10
Indiana	5	3	2			11	2	9	3	1	2	1		19
Maine	7		7		7	32		32	12		12		3	51
Michigan	18	17	1			3		3	6		6			27
Missouri	1	1							9	3	6			10
Montana	35	26	9			17	4	13	8	4	4			60
Nebraska	6	5	1						6	3	3			12
North Dakota	19	19				11	11		12	6	6			42
Oregon	2	2							1	1				3
Pennsylvania	1		1						1		1			2
Texas	5	2	3						4		4			9
Washington	2	2							1	1				3
Wyoming	5	5							2		2			7
Miscellaneous									29	20	9	20		29
Total	137	103	34	3	7	83	25	58	105	44	61	22	3	325

In addition to the above there have been 1,218 tests made upon horses with the complement-fixation method alone, and we have also tested by this method the blood of one lion, which gave a positive reaction, and the blood of one human suspected of having glanders, which proved negative. These two results were later substantiated.

Of the above-mentioned 1,218 tests, 643 were conducted on horses at Washington, D. C., and of these 21 gave a positive reaction, all of which were subsequently confirmed on post-mortem. The remaining 575 were from miscellaneous sources, 78 of which were positive, while 497 were negative.

In the 325 cases shown in the above table, wherein the two tests are compared, the mallein test was confirmed by the complement-fixation test in 161 cases and was not confirmed in 59 cases. There were 105 atypical reactions to mallein which were definitely diagnosed by complement fixation—44 positive and 61 negative. Seven of the Maine reactors to mallein and 3 atypical reactors were examined post-mortem without showing any evidence of glanders.

In order to determine whether the fixation of the complement may be obtained occasionally in normal horses or in horses affected with various diseases other than glanders, a number of tests were made with the blood of apparently normal horses, and also with horses suffering with various infectious and noninfectious diseases. One of these tests was made with the blood of a horse affected with swamp fever, in which the temperature registered 106.2° F.; other tests were

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made with blood from horses affected with distemper, influenza, pneumonia, heaves, lameness, fistulous withers, forage poisoning, etc., but in all these cases negative reactions were obtained.

COMBINED COMPLEMENT-FIXATION AND AGGLUTINATION TESTS.

While the complement-fixation test is without doubt the most satisfactory single method of diagnosing glanders, and although practically all cases giving a complement fixation can be considered as glanderous infections, nevertheless there is a very small percentage of cases in which the complement fixation is not well marked, and in these instances some uncertainty may be felt regarding the final determination of the presence or absence of the disease. Such instances may be met, particularly where the infection is of a very recent origin. Inasmuch as it has been established that the agglutination test gives highly satisfactory results in these early stages of glanders, the application of the combined test appears therefore very advisable. The results which were published by Miessner and Trapp [1] regarding the value of the complement-fixation test and the combined blood test (complement fixation and agglutination) show that about 97 per cent of the cases in which complement fixation is obtained prove to be glanders. On the other hand, by the combined blood test the number of failures in healthy horses is reduced to 1.1 per cent, and in glandered horses to 0; or, as Hutyra and Marek [2] have stated, the combined blood test will prove accurate in 99 per cent of the tests applied.

The agglutination test as it is employed in combination with the complement-fixation test is a modification of the agglutination test which was formerly used, and has been described in detail under the heading of "serum agglutination reaction," on page 356.

Based on the experience gained with the combined blood test, the Prussian minister of agriculture has adopted the following principles for the diagnosis of glanders by this method:

1. Horses the serum of which produces a complete diversion of the complement in the quantity of 0.1 c. c. should be considered glandered without consideration of the agglutination value.
2. Horses the serum of which gives an incomplete diversion of complement in the quantity of 0.1 c. c. or even in the quantity of 0.2 c. c. should be destroyed without consideration of the agglutination value.
3. Horses the serum of which produces no diversion of complement in quantities of 0.2 c. c. should be destroyed if their agglutination value exceeds 1 to 1,000.
4. In every stable of horses where the first blood examination reveals glanders, a second series of samples should be taken on the day of the killing of

[1] Miessner and Trapp. Die Komplementbindung beim Rotz und ihre Beziehung zur Syphilisreaction. Centralblatt für Bakteriologie. Band 52. 1909.
[2] Ibid., p 716.

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the affected animals. If glanders is again found, a third series of samples is taken 14 days after the second series and following the disinfection of the premises. Should the third blood examination prove the presence of additional cases of glanders, the procedure should be repeated, as after the first blood examination.

5. Horses the serum of which does not produce a diversion of complement in quantities of 0.2 c. c. and the agglutination value is less than 1,000, should be considered healthy if the blood was taken at least 14 days after the removal of the sources of infection. If the time when the sources of infection were removed can not be positively determined, a second series of blood samples should follow the first. If the second examination of the blood shows the same result as the first, the horses should be considered healthy.

6. The blood examination of the horses in the stable should be considered as concluded when the above requirements have been carried out.

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THE REGIONAL LYMPH GLANDS OF FOOD-PRODUCING ANIMALS.

By JOHN S. BUCKLEY, D. V. S., *Assistant in Pathology, Pathological Division,*
AND
THOMAS CASTOR, V. M. D., *Veterinary Inspector, Philadelphia, Pa.*

This paper dealing with the topographical anatomy of the lymphatic apparatus of food-producing animals has been written in an endeavor to meet a need that must be felt by practically every beginner in that branch of sanitary hygiene which has to do with the examination of meats and the organs or carcasses of meat-producing animals. It is regrettable that a more absolute knowledge does not exist of the anatomical detail of this system in the various food animals, but an endeavor has been made to supply as much as possible of the general knowledge that could be gleaned from the various works that treat of this subject, together with a fair amount of original investigation carried out by the writers of this paper.

Hitherto no great amount of special attention has been devoted in the veterinary schools to the study of the lymphatic system, but the prominence which has lately been given to the inspection of meats and carcasses of meat-producing animals necessitates a closer acquaintance with all that pertains to these structures, as intelligent judgment as to the fitness or unfitness of meats for human consumption is based largely on the conditions found in the lymph glands. As it is in the diseased carcasses that we find presented the ideal conditions for the best appreciation of the whole lymphatic apparatus, to the novice in meat inspection an exceptional opportunity is there afforded for its study which should on no account be neglected.

DESCRIPTION OF THE LYMPHATIC SYSTEM.

The lymphatic system presents for study the lymph and its cellular constituents, the lymph vessels and lymph glands, together with certain accessory lymphatic structures which form a part of the system.

THE LYMPH.

The lymph itself is identical with the plasma of the blood and contains cellular elements which vary much at different periods and in different parts of the animals at the same time. In the intercellular lymph spaces and in the finest lymph radicles it has a poor cellular

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content, while it possesses rich cellular contents as it leaves the lymph glands. These cellular elements are variously classified by different histologists, one of the most convenient classifications being that based on their size, form of nucleus, and structure, into large lymphocytes, small lymphocytes, polynuclear leucocytes, and transitional leucocytes. According to their granules and their staining characters they are classified as eosinophiles (or oxyphiles), basophiles, and neutrophiles.

THE LYMPH VESSELS.

Looking at the lymphatic apparatus in a normal healthy individual, we find it to be made up of a system of tubes or conduits, sometimes designated the white blood vessels, beginning as terminal culs-de-sac in the tissue interspaces, coursing as intricate and extensive networks in practically all tissues excepting muscles bundles (but they do not exist in the intermuscular sheaths), nerves, and blood vessels, and terminating finally as two large lymph vessels known as the thoracic duct and the great lymphatic vein, which empty into the blood vascular system near the junction of the jugular veins in the anterior vena cava.

Within the lymph vessels are situated involutions of the endothelial lining, forming valves which correspond to the valves of the veins, these valves being much more numerous, though, than in the veins. The smallest lymph vessels, i. e., the lymph capillaries, do not contain valves, nor are valves at all numerous in the thoracic duct, although several do exist at its juncture with the veins, these forming a contrivance to prevent passage of blood backward into the thoracic duct. But in all the vessels of an intermediate size the valves may readily be seen in injected preparations as constricted nodes about one-sixth of an inch apart.

In many respects the lymph vessels simulate the veins of the blood vascular system both in structure and function. They are, in fact, adjuncts of that system.

The capillary lymph vessels are formed by a single layer of endothelial cells, as are the smallest of the blood capillaries, and according to late investigations are said to have their origin in closed terminal culs-de-sac instead of open intercellular lacunar spaces.

Aside from the possession of valves, the intermediate and large lymph vessels are made up of three coats, as are the veins (an inner endothelial, a middle muscular, and an outer connective tissue envelope), and are said to divide about equally with the veins the absorbent functions. It is to be noted that those lymph channels of large size also possess elastic fibers, these acting in a mild degree for the impelling of the lymph onward toward the blood.

The lymph collected by the lymphatics from all parts of the body is finally emptied into the blood stream through the agency of the

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two large vessels already mentioned—the thoracic duct and the great lymphatic vein.

The thoracic duct has its origin in a very irregularly shaped cystic dilation known as the reservoir of Pecquet, or the receptaculum chyli, situated beneath the first lumbar vertebra near the adrenals. From this origin it extends forward through the diaphragm (in cattle by a special opening), passing along the lower surface of the dorsal vertebræ and above the aorta to the apex of the thorax, and empties into the anterior vena cava. This duct receives the lymph from all parts of the body except from the right fore limb and the right half of the head, neck, and thorax. The thoracic duct is sometimes double throughout its extent, originating in the one reservoir and emptying at the junction of the two jugulars.

The great lymphatic vein, or the right lymphatic vein, is an extremely short trunk which receives the lymph from the right side of the head, neck, thorax, and right fore limb and empties into the venous system at the junction of the jugular veins or anastamoses with the thoracic duct just above the point of juncture with the anterior vena cava. It is formed by the efferents of the prepectoral glands of the right side.

THE GLANDS.

On the course of the lymph vessels are interpolated adenoid structures called lymph glands. The glands are nodular organs, varying in size from almost imperceptible points to that of a hen's egg, and varying also as regards the species of animals. In form they may be flattened, round, cylindrical, or reniform. Usually, though, they are more or less reniform (i. e., kidney shaped). The lymph vessels approaching a gland enter, after breaking up into many branches, in an oblique direction on its convex border and are known as the afferent vessels. These are the conduits that convey the lymph directly from the various tissues to the respective or corresponding lymph glands. After having traversed a complex labyrinth of channels in the gland and having its composition altered both chemically and histologically, the lymph leaves the gland by the efferent lymph vessels which have their origin at the hilus of the gland, situated on its concave border. These efferent vessels either enter into another gland or pass directly to the receptaculum chyli, the thoracic duct, or the right lymphatic vein.

An idea of the structure of a gland may be gotten from a study of the lymph follicles in the walls of the intestines, and then of a plexus of lymph vessels, within the meshes of which are placed these simplified collections of germinating lymphatic cellular elements.

A lymph follicle as found in the intestinal mucosa is nothing more than a small round aggregation of proliferating lymph cells held in

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an extremely delicate stroma of adenoid connective tissue and penetrated by a richly arborescent capillary arterial twig which furnishes it nutriment. Surrounding some of these aggregations of lymphatic cellular elements is an extremely delicate connective tissue capsule opening into and continuous with the surrounding lymph capillaries, much on the order of a Bowman's capsule covering a Malpighian corpuscle in the kidney.

The lymph gland might be considered to be nothing more nor less than a large collection of these simple lymph follicles held together by a connective tissue framework containing trabeculæ which separate the follicles and surrounded by a thick capsule from which this framework takes its origin. Intermixed with the fibers of connective tissue are involuntary muscle fibers in the lymph glands of some of the lower animals. The individual follicles of this compound gland do not completely fill the alveoli formed by the trabecular framework, but are surrounded in each instance by a hollow space which corresponds to the space between the capsule mentioned above as surrounding a solitary follicle and the follicle itself. In the compound lymph gland these spaces are all continuous with one another toward the medullary portion of the gland. The follicles of the medullary portion are elongated structures and are known as the medullary cords. The intercommunicating follicular lymph spaces finally are continuous with the efferent lymph vessels of the gland. For convenience of description the structure of the lymph glands is usually described as being divided into a cortical and medullary portion, the only difference in the two being in the shape of the lymph adenoid structures, those in the cortical portion being round and called cortical follicles, and those in the medullary portion being elongated and known as medullary cords. The spaces surrounding the follicles and cords are known as the lymph sinuses, and it is through the sinuses that the lymph passes on its way from the afferent to the efferent lymph canals. It is while traversing these tortuous sinuses that the lymph is altered in composition. From a meat-inspection standpoint it is well to remember that foreign and deleterious matter that has been taken up by the lymph on its passage through the different tissues is oftentimes removed or destroyed either by a process of filtration or by chemical counteraction. This function of the gland is very important, as certain deleterious substances—such, for instance, as infectious micro-organisms (tubercle bacilli for a specific example)—if emptied unceremoniously by the lymphatics into the blood stream would probably be distributed over the whole organism and would likely set up a generalized infection—a septicemia—which would most probably soon terminate in death. The lungs, of course, filter out many germs that are thus emptied into the blood streams.

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The bacteria filtered out or retained temporarily by lymph glands are often destroyed and disintegrated. However, such is not always the case, and bacteria may even pass through a lymph gland without leaving any trace of their passage. Many of the bacteria which are retained are chemically treated and disintegrated, or, not being destroyed, they produce disease of the glands. Other substances, such as particles of carbon, are filtered out and may be readily seen in the bronchial glands of nearly all old animals. Blood and other tissue pigments are seen in the glands where there has been a destruction of these tissues upstream. Parasites, too, are at times found in these structures.

The lymph as it leaves the gland is much altered. It is in the gland that some of the lymph corpuscles, which play such an extremely important part in the protection of the body from infections and injuries, are added to it. It is while thus passing through that the lymph acquires its property of coagulability, i. e., it receives its fibrinogenetic qualities. The lymph with its new qualities and new constituents, together with its load of modified waste from the tissues, is now ready to be emptied into the blood stream to be passed along to the excretory organs.

The statement that the lymph glands filter out and modify deleterious matters could not be very readily demonstrated by simple macroscopic means in a young, healthy animal, but it is clearly exemplified in cases of infections of individual organs and regions and in old animals where pigmentation of these glands is often observed. It is on such findings that the meat inspector is most often obliged to depend for basing his opinion of health or disease, and for deciding localization and generalization of disease and the fitness or the unfitness of meat for food purposes.

If the lymphatic system is the "scavenger of the body," if it protects the body from disease, it also furnishes a route of entry for disease, and in certain cases acts as a disseminator of disease. Those cancerous affections and infectious diseases of a malignant character which have by intent or chance become inoculated into the body are not long held in abeyance by the lymph glands, for the lymph conduits act as ways of transport in such cases, to the detriment of the whole body.

In consistency and color the lymph glands vary much. In young, rapidly growing animals the glands are quite prominent and juicy; in old and mature animals they are more firm and compact. Sometimes in old milch cows the lymph glands may be quite prominent, but are usually fibrous in texture. The splanchnic lymph glands are softer in structure than those in other parts of the body, those of the abdominal digestive organs being more juicy, especially during absorption from the intestines.

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The interior parts of the mesenteric glands are usually darker in color than those of other regions. The colors that prevail are white, light gray, dark gray, mottled gray and brown, light brown, and sometimes red or even black.

The red lymph glands usually represent a special kind of gland known as hemo-lymph glands, the color being due to the presence of red blood cells in the sinuses. These are quite normal glands, and are thought by some to be transitional forms, or forms induced by alterations in other organs, especially the spleen, and by others are supposed to relieve the spleen of a part of its function in the metabolism of the blood. These small red glands usually occupy a position in the sublumbar region and are designated by Warthin as "spleenolymph glands" and "marrowlymph glands."

Black lymph glands, or mottled black and white, while not normal, can not be said to be always really diseased, since the color may be due to a mere deposition of normal pigment or to carbon particles which have no special significance, at least from a meat-inspection standpoint. The cortical portions of many lymph glands are white or light gray, while the medullary portions are rather dark in color. In many old animals the lymph glands are quite fibrous in texture, and on section are of a yellowish-white color.

Although the routes of the lymph conduits are more or less constant, there may easily be diversions of the normal or usual flow of lymph, due to various causes, the most important of these being the retrograde movements, due to blocking of the lymph channels in disease, as in cancerous and other conditions. Anastomoses of lymph vessels of adjacent regions may occur, as in inflammatory adhesions of one lobe of the lung with an adjacent lobe, or adhesion between the visceral and parietal or the visceral and mediastinal pleura, etc. All such points must constantly be kept in mind in order to render intelligent judgment in a seemingly unexplainable finding.

THE SUBMAXILLARY LYMPH GLANDS.

The submaxillary lymph glands in cattle are located superficially in the lower portion of the inferior maxillary space, between the inner aspect of the inferior maxillary bone and the submaxillary salivary glands, about 2 inches anterior to the point where the lower border of the inferior maxillary bone curves abruptly upward and above the anterior attachment of the sterno-maxillaris muscle. Usually there is but one node on each side, but at times there are two glands lying very close to each other. (See Pl. XXX, 4, and fig. 27, *b*.)

In hogs, these glands lie, covered by the salivary glands, more posterior than in cattle. (See fig. 28, 9.)

Their afferent vessels, chiefly superficial, are derived from the mucous membrane of the anterior nares, the muscles of the lips,

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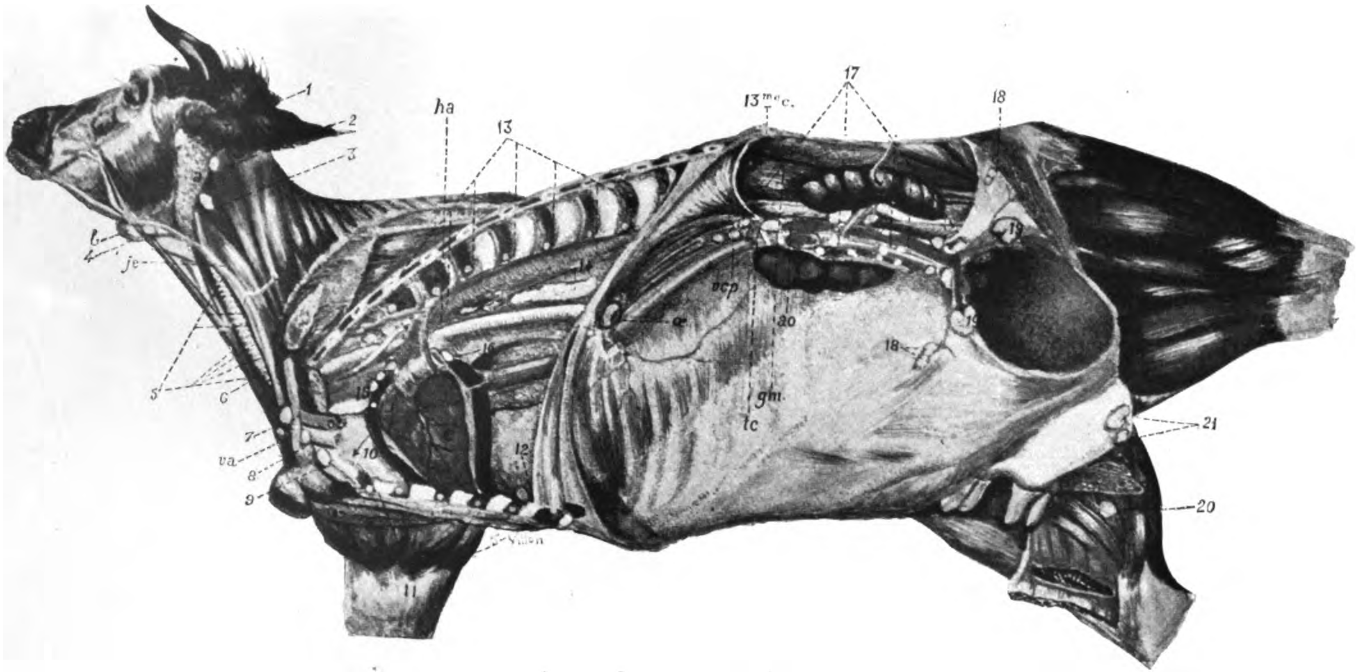

LYMPH GLANDS IN THE COW.

1, Parotid lymph gland; 2, atlantal lymph gland, or the most superior of the superior cervical lymph glands; 3, postpharyngeal lymph gland; 4, submaxillary lymph gland; 5, small glands on the median portion of the superior face of the trachea; 6, prescapular lymph gland; 7, 8, 9, prepectoral lymph glands; 11, inferior thoracic or suprasternal lymph glands situated along the course of the internal thoracic artery and vein; 12, sterno-diaphragmatic lymph gland; 13, superior thoracic or sub-dorsal lymph glands; 14, chain of lymph glands in the posterior mediastinal region; 15, lymph nodes along the inferior surface of trachea in the anterior mediastinal space; 16, posterior bronchial lymph gland, under the bifurcation of the trachea; 17, sublumbar lymph glands, at *vcp* the most anterior are at the origin of the celiac arteries; 18, external iliac or circumflex iliac lymph glands, at the angle of the haunch; 19, external iliac lymph glands at the angle of the crural trunk; 20, popliteal lymph gland; 21, superficial inguinal or supramammary lymph glands. (From Aureggio's "Album Guide.")

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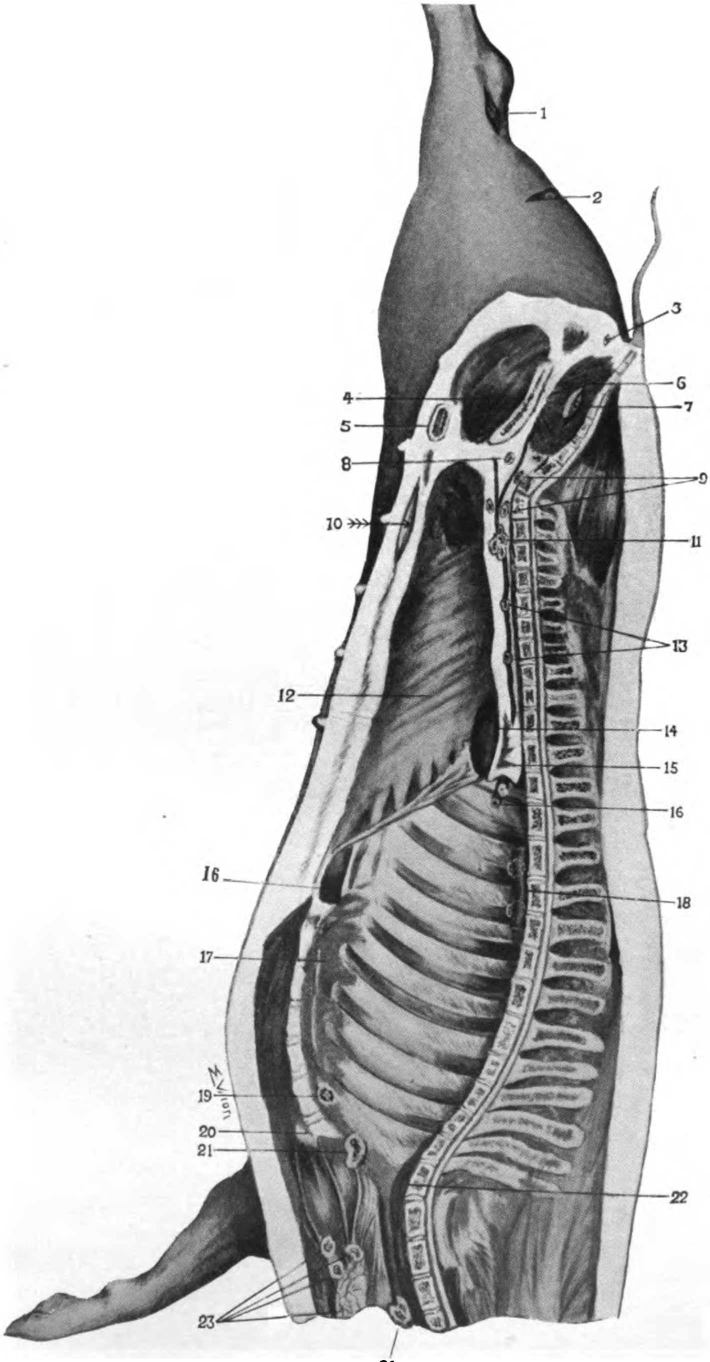

LYMPH GLANDS IN THE HOG.

1, Incision to expose the gland of the hock; 2, popliteal lymph gland; 3, anal lymph gland; 5, superficial inguinal lymph gland; 6, internal obturator muscle; 7, ischial lymph gland; 8, posterior node of the internal iliac lymph glands; 9, subsacral lymph glands; 10, incision to expose the external inguinal lymph glands; 11, group of lymph glands in the sublumbar region, continuous with the internal iliacs; 13, sublumbar lymph nodes; 14, kidney; 16a, sterno-diaphragmatic lymph gland; 18, small lymph nodes along the aorta; 19, inferior thoracic or suprasternal lymph gland; 21, prepectoral lymph glands; 23, glands of the median cervical region, seen usually still attached in the dressed carcass; 24, postpharyngeal or retropharyngeal lymph glands. (From Aureggio's "Album Guide.")

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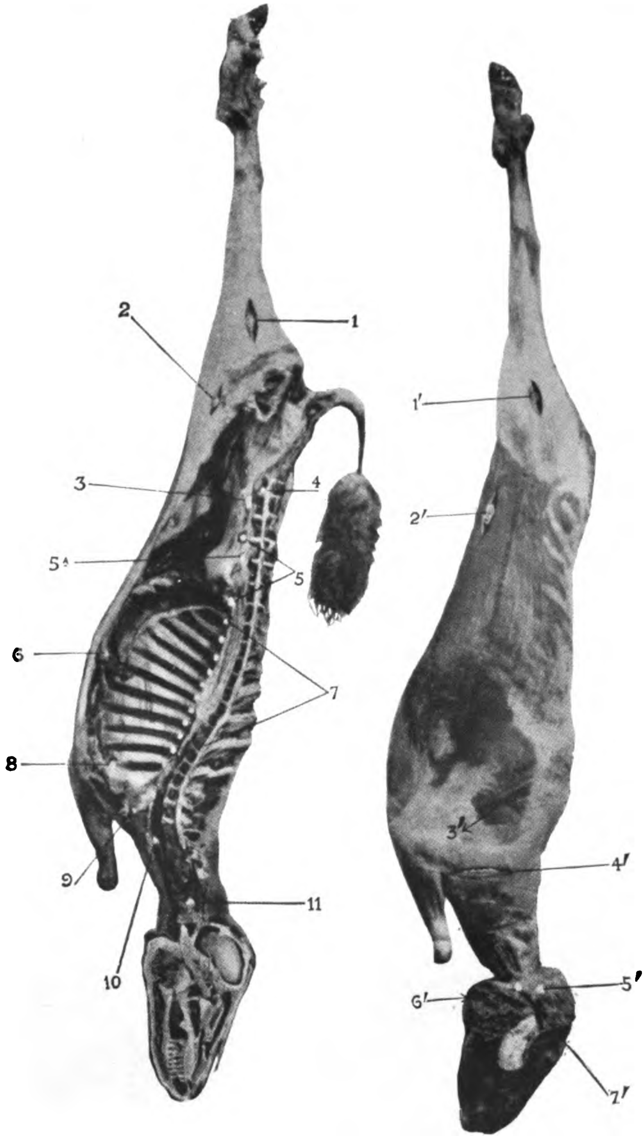

LYMPH GLANDS IN THE SHEEP.

1, 1', Popliteal lymph gland; 2, superficial inguinal lymph gland; 2', precrural lymph gland; 3, internal iliac lymph gland; 4, 5, sublumbar lymph glands; 5A, renal lymph gland; 6, sterno-diaphragmatic lymph gland; 7, superior thoracic or subdorsal lymph glands situated along the aorta; 8, suprasternal lymph gland; 4', 9, prescapular lymph gland; 10, small nodes along the superior face of the trachea; 11, superior cervical or postpharyngeal lymph gland; 3', axillary lymph gland; 5', parotid lymph gland; 6', submaxillary lymph gland; 7', atlantal or preatloidian lymph gland. (From Aureggio's "Album Guide.")

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cheeks, and tissues of the anterior maxillary space, and from the anterior portion of the tongue. The efferent or outgoing lymph vessels pass to the superior cervical lymph glands.

In cattle the head is often severed from the carcass without removing the tongue and is so inspected, and in this case the submaxillary lymph gland is reached by making a longitudinal incision just within the angle of the inferior maxilla along the inner border of the sterno-maxillaris muscle, when it will be found adjacent to the submaxillary salivary gland. In other cases the tongue is removed from the head and hung up by its tip, when the gland may very easily be reached by grasping the side of the base of the tongue with one hand to draw the tissues tense, and then making one or more short transverse incisions to the inside of the sterno-maxillaris muscle and directly opposite to the arytenoid cartilage of the larynx. These incisions should cut directly through the submaxillary lymph gland, thus exposing it for inspection.

Fig. 27.—Head of cow, with tongue cut out. *a*, *a'*, Postpharyngeal or retropharyngeal lymph glands; *b*, submaxillary lymph glands; *c*, tonsils; *d*, posterior nares; *f*, submaxillary salivary gland; *g*, styloid process of hyoid bone. (From Edelmann's "Meat Hygiene.")

In hogs the method of reaching these glands varies with the method of slaughtering. In many of the smaller establishments where the killing is slow and the work of inspection is conducted by one inspector at the eviscerating bench, it is the custom to remove the liver, lungs, heart, and tongue without separating them, and in this case the submaxillary lymph glands may be easily removed from the carcass with the tongue if a good, wide incision is made and then both sets of glands may be readily located a short distance apart embedded in the fat on each side of the tongue; but it is necessary to distinguish between the lymph glands and the salivary glands, which are also removed by this method and lie adjacent to the submaxillary lymph glands. In the larger establishments where the killing is conducted very rapidly these glands are examined on the scraping or heading bench, the head being almost severed from the body by a free transverse incision at the throat, after which the glands may be readily found in the location previously described by

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making a longitudinal incision through the salivary gland and into the adjoining submaxillary lymph glands, thus exposing them for inspection. Some inspectors use a small hook with which the salivary gland is drawn outward and twisted slightly, thus allowing the adjoining lymph glands to be exposed easily and rapidly with a small incision. Experience is necessary to locate them rapidly and accurately, so as not to delay or hinder the killing operations.

THE PAROTID LYMPH GLAND.

In cattle the parotid lymph gland is located at the supero-anterior border of the parotid salivary gland, being partly embedded in the same and partly lying on the masseter muscles about 1 inch in front of and a little lower than the external meatus of the ear. (See Pl. XXX, 1.)

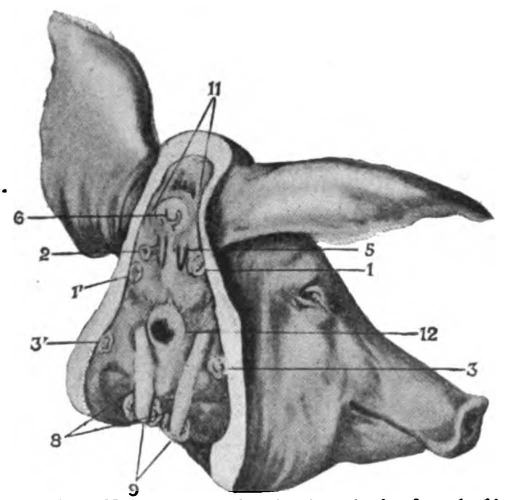

FIG. 28.—Head of hog, showing lymph glands. 1. 1'. Parotid lymph glands; 2, postpharyngeal or retropharyngeal lymph glands; 3, 3', superior cervical lymph glands; 8, submaxillary salivary glands; 9, submaxillary lymph gland on each side of the salivary gland in the intermaxillary space. (From Aureggio's "Album Guide.")

In hogs the parotid glands, very numerous, large, and red in color, are arranged in a chain along the anterior border of the parotid salivary gland and posterior to the border of the inferior maxillary bone. (See fig. 28, 1 and 1'.) On the killing beds it will be noticed that very often one or more of them are left intact on the inner surface of the jowl after the head is removed in that method of slaughter where the jowls are allowed to remain attached to the carcass. Where the jowls are removed from the carcass with the head, as is done in many of the larger slaughterhouses, these glands may often be easily seen, as they are frequently cut through when the head is severed from the body, although in some cases they may be entirely removed with the head and jowls, or in others they may remain in the carcass, depending entirely whether the head is cut off long or short.

The afferent vessels, chiefly of the deep variety of lymphatics, are derived from the anterior and lateral portions of the head and from the temporal and parotid regions, the cranial cavity, the base of the cranium, the tongue, the soft palate, the esophagus, and the larynx. The efferent vessels pass to the superior cervical lymph glands.

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THE POSTPHARYNGEAL LYMPH GLANDS.

The postpharyngeal or retropharyngeal lymph glands are located in cattle at the base of the cranium just superior to the pharynx, lying close on either side of the median line between the branches of the hyoid bone. (See Pl. XXX, 3, and fig. 27, *a* and *a'*.) These glands consist of two quite large nodes, one on each side.

In hogs they are usually quite small and are situated more posterior than in cattle, on the lateral plane of the larynx and the pharynx at about the lower end of the styloid process of the occipital bone. (See fig. 28, 2, and Pl. XXXI, 24.)

They receive lymph radicles from the posterior nares, the cranial cavity, the posterior portion of the oral cavity, the tonsillar region, and the pharynx, also from the other lymph glands of the head. The tonsils, in cattle at least, have four or five large ducts that empty directly into the postpharyngeal glands.

The efferent lymph vessels pass to the other superior cervical glands that lie above the pharynx but more posterior and external to the hyoid bone—the parapharyngeal glands—after which they pass down along the trachea following the carotid artery to the middle cervical glands.

It will readily be seen how very important these glands are, from a meat-inspection standpoint, as they receive most of the efferent lymph radicles of the entrance to both the digestive and the respiratory tracts. Indeed, it is a matter of fact that these glands are often the very first to show tubercular infection. And, too, those animals affected with actinomycosis that have the postpharyngeal glands involved usually show nodules of actinomycotic growth in the lungs. This would appear to indicate that the lymphatics are not always a protective factor in disease, but in this case their efferents possibly furnish a route by which this disease soon gains entrance to the blood and is filtered out in the lungs.

These glands may be exposed in cattle as follows: Where they are examined in the head after its removal from the carcass, but before the tongue is cut out, draw the larynx downward with the hand (or upward and forward when the head is lying face downward, as is ordinarily the case), then make a free transverse incision near the base of the cranium, which will reveal the glands lying on the supero-posterior surface of the pharynx. If the tongue has been cut out and hung up by its tip, it is a very simple matter to examine the glands as they are exposed to view on the wall of the pharynx at the superior part of the base of the tongue. When the pharynx is not opened up longitudinally they lie almost adjoining each other in the median line, whereas if it is opened, as it should be, to clean it of particles of food, mucus, etc., the glands will drop somewhat—one to each side—but hanging in full view at the level of the anterior

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border of the arytenoid cartilage. This position will of course vary somewhat when the tongue is hung up by its base, as is sometimes done.

In hogs the method of locating these glands is similar to that described for the submaxillary glands, the only difference being the slight difference in location, the postpharyngeals being located in a mass of fat at each side of the larynx and pharynx, and not so large or prominent as the submaxillary glands.

THE CERVICAL LYMPH GLANDS.

The term "cervical lymph glands," as used in the meat-inspection regulations and reports of the Bureau of Animal Industry, includes the submaxillary, the superior cervical, the postpharyngeal, the parapharyngeal, and the parotid lymph glands. These are very important to the inspector, and it is necessary to examine them carefully. In hogs especially the cervical lymph glands frequently present the first and often the only lesions of tuberculosis found in the entire carcass.

When tuberculous lesions are found in any of the cervical lymph glands in a carcass that is to be passed for food or lard, the head and tongue should be condemned and tanked, or may be passed for lard, depending upon the extent and severity of the lesions, but if passed for lard all the cervical lymph glands should be carefully trimmed out, and in either case all of the lymph glands of the neck region, including the prepectoral, the prescapular, the middle cervical, and the deep or supplementary cervical glands, should be thoroughly trimmed out and tanked.

THE SUPERIOR CERVICAL LYMPH GLANDS (ATLANTAL, PARAPHARYNGEAL, AND ANTERIOR CERVICALS).

These glands are located in cattle at the extreme superior end of the submaxillary salivary gland, just under the styloid process of the occipital bone, and bordering the lateral aspect of the occipito-atloid articulation just above the pharynx. They consist of a small group, two or three in number. (See Pl. XXX, 2, and Pl. XXXII, 7′.)

The superior cervical glands in hogs are very important ones to examine for tubercular infection. See also the middle cervicals, which are continuous with these in the hog. (See Pl. XXXI, 23, and fig. 28, 3 and 3′.)

They receive afferent vessels from the immediate surrounding tissues, and the efferent branches from the three preceding glands. Their efferents pass, accompanying the large blood vessels lying beside the trachea, to the inferior cervical glands, at times directly, at times through one of the small glands, interposed on their course, known as the middle cervicals.

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THE MIDDLE CERVICAL LYMPH GLANDS.

These are small glands, several on each side, against the wall of the trachea and esophagus, just a little lower than the thyroid gland. (See Pl. XXX, 5.) Large nodes are never present except occasionally in the sheep. It will be found that the efferent lymph vessels of the superior cervical glands pass through the nodes that may be present. These glands receive afferent radicles from the esophagus and the trachea. Their efferents pass directly to the prepectoral lymph glands. In hogs these glands are continuous with the superior cervical chain which extends upward to the occipital bone. (See Pl. XXXI, 23.) In cattle they are often absent.

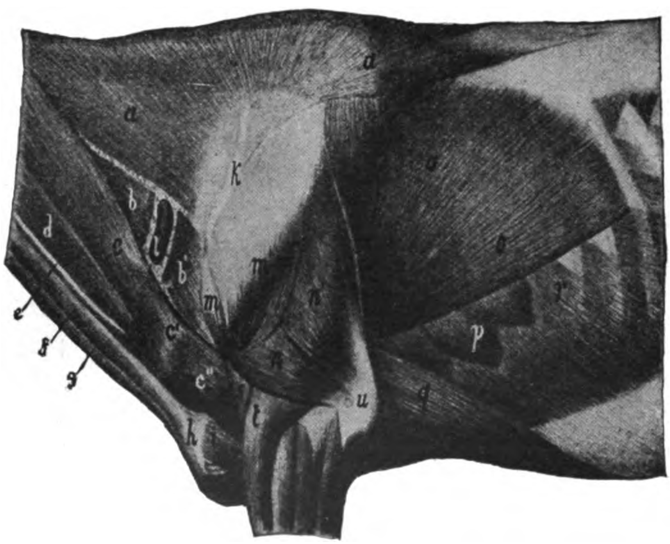

FIG. 29.—Left fore quarter of heifer, with exposed prescapular lymph gland. *a, a,* Cervical trapezius muscle; *b, b',* omotransversarius muscle; *c, c', c'',* brachiocephalic muscle; *l,* prescapular lymph gland. (From Edelmann's "Meat Hygiene.")

THE PRESCAPULAR OR SUPERFICIAL CERVICAL LYMPH GLANDS.

These glands are located a little above and inward from the shoulder joint, embedded in a cushion of fat and covered by the mastoido-humeralis muscle. This gland in cattle consists of an elongated voluminous glandular node (see Pl. XXX, 6, and fig. 29, *l*); in hogs, a more or less completely fused chain. They play an important part in deciding the question of generalization of disease—in tuberculosis, for example—as the afferents are all derived from centripetal lymph ducts, i. e., from ducts that are not connected with any other lymph area. In other words, this lymph area is an isolated area, so that any secondary infection coming in it must first be brought to this area through the medium of the blood vessels. Perhaps inflammatory conditions which would cause anastomoses with the lymph

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vessels of an adjoining region might take place. In this manner pleural lymph radicles could become fused with deep-lying lymph vessels on the pectoral wall, and these in turn pass over the shoulder to the prescapular glands. It would seem that such a roundabout course would almost never take place. Of course disease of these glands without other centers of infection would point to a primary local infection.

The afferent radicles are derived from the superficial parts of the shoulder, the upper and lower leg, the posterior portion of the lateral pectoral wall (the vessel in this latter case passing to these glands across the muscles of the shoulder), from the superficial parts of the base of the neck, and from part of the inner face of the scapular region.

The efferent vessels pass to the prepectoral lymph glands, i. e., the inferior cervicals.

The glands may usually be felt in live cattle by pressing the hand forcibly in the hollow of the shoulder, about in front of the neck of the scapula. In a side of beef in the hanging position a small cut parallel to the muscle fibers along the superior border of the mastoido-humeralis muscle, 3 inches in length, just inward from the shoulder joint, will be sufficient for the inspector to reach in and secure the gland for examination. The muscle can then be laid back in place, flattened out with the hand, and held there with a skewer, so that when the carcass cools it will be scarcely possible to notice any sign of the muscle having been disturbed. It may also be reached for examination from the inner surface of the split beef carcass by making a longitudinal incision through the neck muscles in the jugular gutter just anterior to the scapulo-humeral articulation. This method is preferred by many inspectors.

In hogs it is easiest reached from the internal or split surface of the carcass by making a transverse cut just in front of the shoulder joint from the nape of the neck to the trachea some distance anterior to the first rib, and the lymph gland will be found to occupy a place about in the middle of the incision.

It is also quite important to examine these glands in sheep to detect diseases such as caseous lymphadenitis. In sheep the glands are located as in cattle. (See Pl. XXXII, 9.)

This gland, like the other bond glands, is, as a rule, only examined in the final examination of retained carcasses, as to expose them mutilates the carcass more or less.

THE DEEP CERVICALS OR SUPPLEMENTARY CERVICAL LYMPH GLANDS.

These glands are located, in hogs, above the superficial cervical glands beneath the angular muscle of the scapula, external to the lower part of the second cervical vertebra, embedded in a mass of fat.

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The afferent vessels are from the deep muscular layers of the base of the neck. The efferent vessels pass to the superficial cervical or prescapular gland.

In cattle this gland does not exist.

This gland can be reached in the hog after the carcass has been split by cutting through the neck muscles inferior to the first and second cervical vertebræ. To reach the gland in this manner mutilates the neck somewhat and occasionally the shoulder to a slight extent. A still better way—as it causes very little mutilation—is, in the hanging, split decapitated carcass to make a free upward incision between the neck muscles covering the first and second cervical vertebræ and the layer of superficial fat, when the gland can be readily reached in a cushion of fat somewhat anterior to the scapula and torn loose and brought out for examination.

This gland is considered in the work of the Bureau of Animal Industry as a portion of the prescapular glands and should be so named in making out reports.

In the superficial parts of the base of the neck and shoulder there are also several other very small lymph nodes.

THE AXILLARY OR BRACHIAL LYMPH GLANDS.

These glands are located in cattle on the inner aspect of the internal scapular muscles, posterior to the shoulder joint, in the midst of the brachial vessels and nerves where these emerge from the thorax and enter the leg. They are variable in number and usually are smaller and more flattened than any of the glands so far described.

The axillary lymph glands are most often missing in swine, and the lymph of this region empties into the median or inferior cervicals.

The gland is accessible only from the external surface after removing the scapula, which is ordinarily impracticable in a food carcass, but may be easily reached in cattle from the inner surface of the split carcass, as it lies just external to the first or second rib (usually the latter) at about midway between its two extremities; and by cutting through the muscles along the anterior border of the first rib near its center the gland may be readily located embedded in a cushion of fat external to the first or second rib. This gland is not examined in the ordinary post-mortem meat inspection.

They receive their afferent rootlets from the middle and inner scapular region, from the lower arm, forearm, and foot, and from the thoracic walls. Their efferent vessels pass to the prepectoral or inferior cervical glands.

THE PREPECTORAL OR INFERIOR CERVICAL LYMPH GLANDS.

In cattle and hogs these glands are located at the entrance to the thorax on and between the lower anterior borders of the two first ribs laterally and inferior to the trachea and esophagus, extending

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into the fore part of the anterior mediastinum, usually embedded in fat that also acts as a cushion for the large veins and arteries at this location. (See Pl. XXX, 7, 8, 9; Pl. XXXI, 21, and fig. 30, *b*.)

These are very important glands to examine, as they are the terminal glands through which all the lymph from the head, neck, and fore extremities passes on its way to the thoracic duct and the right lymph vein. They also receive the efferents of the suprasternal lymph glands on their passage to the thoracic duct and from several small lymph nodes in the anterior mediastinal space. They bear the same relation to the anterior portion of the body as do the sublumbar glands to the vessels of the posterior regions. The efferents of the prepectoral glands on the right side empty into the great lymphatic vein, and on the left side into the thoracic duct or occasionally into the anterior vena cava. These glands are frequently found to be affected with tuberculosis, so occasionally lesions of that disease may be thus detected even after the viscera have been removed and disposed of.

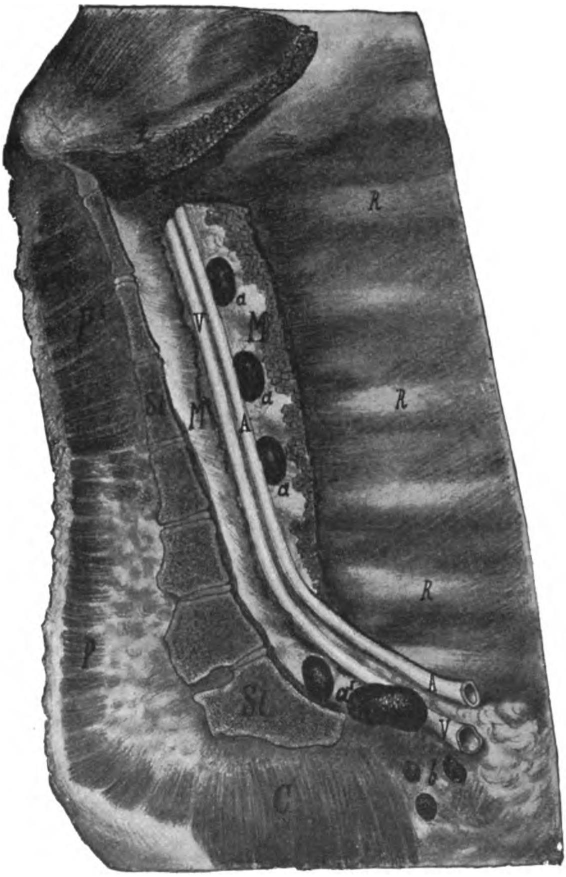

FIG. 30.—Portion of left thoracic wall of heifer. *A*, internal thoracic artery; *V*, internal thoracic vein; *M*, triangular muscle of the sternum cut through; *a*, inferior thoracic lymph glands; *a'*, anterior mediastinal lymph glands; *b*, inferior cervical or prepectoral lymph glands. (From Edelmann's "Meat Hygiene.")

These glands, or at least a portion of them which always remain in the hanging split carcass of beef, may be easily reached by inserting the knife into the cut end of the large venous trunk above referred to and making a downward longitudinal incision parallel to the fibers of the long muscles of the neck, where the gland may be readily found embedded a short distance in the fatty cushion.

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Proceeding somewhat in the order of examination of the carcass as it is conducted at the time of evisceration, or following the plan of inspection by passing from terminal to central lymph structures as the lymph flows, we have the following glands:

THE POPLITEAL LYMPH GLANDS.

The popliteal lymph glands are located deep in the muscles behind the knee joint on the gastrocnemius between the semitendinosus and biceps femoris muscles at about the point of bifurcation of the gastrocnemius. (See Pl. XXX, 20, and Pl. XXXII, 1, 1'.)

In hogs the popliteals are absent in some instances, but there exists always a very small gland in the subcutaneous tissues 3 or 4 inches above the hock. (See Pl. XXXI, 1, 2.)

The popliteal gland is not examined ordinarily, this not being considered necessary except in special cases, as it mutilates the carcass considerably to expose it. To reach it in the hanging cattle carcass, make an incision on the posterior part of the thigh, parallel to the muscle fibers, between the biceps femoris and the semitendinosus muscles, on a line from the point of the ischium to the point of the os calcis, at the intersection of a horizontal line drawn backward from the center of the patella. The fingers may then be thrust in between the muscles to the cushion of fat between the heads of the gastrocnemius, where the gland may be readily located.

The afferent vessels are from the lower portion of the hind leg. The efferent vessels follow the sciatic nerve, pass upward to a lymph gland (the ischial) lying on the outer portion of the ischium in the middle of the lesser ischiatic notch, thence to the posterior sublumbar gland. At times they pass by this gland without entering it and pass directly to the sacral or sublumbars or the internal iliacs.

THE ISCHIAL LYMPH GLANDS.

These glands are located on the deepest and outer part of the lesser ischiatic notch, adjacent to the external surface of the bone, covered by the broad ligament of the pelvis, on the ventral border of the coccygeal muscle. (See Pl. XXXI, 7.)

The afferent vessels are derived from the surrounding region and from the efferent branches of the popliteal glands. Sometimes the efferents of the popliteals pass quite near to this gland without entering it.

The efferent vessels of this gland pass to the sacral and sublumbar glands.

THE PRECRURAL, KNEEFOLD, OR EXTERNAL SUBILIAC LYMPH GLAND.

This gland forms a voluminous mass located in the loose cellular tissue of the flank just above and inward from the femero-tibial articulation on the anterior border of the tensor fascia lata muscle.

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(See Pl. XXXI, 10, and fig. 31, *l*.) In animals in good condition it is embedded in a mass of fat. It is one of the most accessible glands in the dressed carcass, and is quite as important from the meat-inspection standpoint as is the prescapular gland in the fore quarters. In sheep this gland is very often affected with disease, and it is quite important to keep this in mind at the time of inspection. (See Pl. XXXII, 2′.)

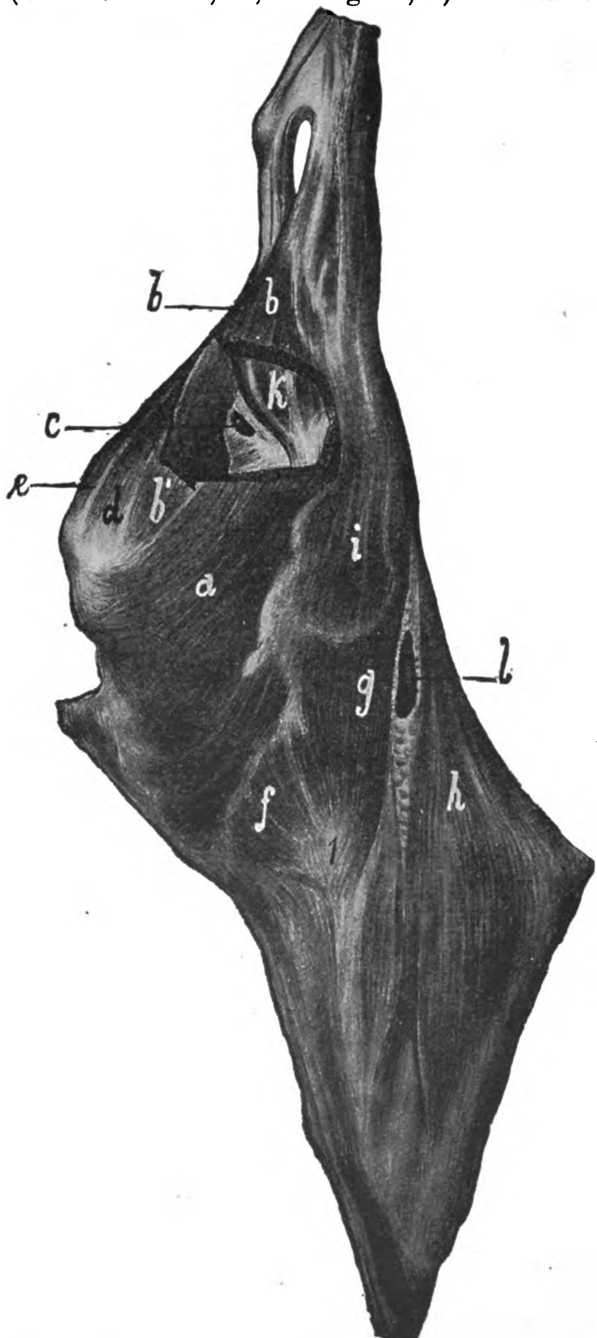

FIG. 31.—Left hindquarter of steer, external view. *c*, Popliteal lymph gland; *l*, precrural lymph gland; *b*, *b′*, biceps femoris muscle; *c*, semimembranosus muscle. (From Edelmann's "Meat Hygiene.")

The afferent lymph ducts are derived in part from the lateral abdominal wall, in part from the superficial aspect of the thigh, and from the outer and superior portions of the hind extremities, also from the large crural muscles. The efferents pass upward several inches along the fascia lata muscles, pass through the abdominal wall, and enter the circumflex iliac lymph glands by several large vessels.

In the hog this gland can be readily found with the least mutilation of the

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carcass by making a free incision through the inner abdominal wall nearly perpendicular to the vertebral column and in front of and above the femero-tibial articulation. In cattle it is easiest reached from the external surface of the carcass in the region known to the butcher as the "fel," by cutting down somewhat more deeply than is ordinarily done by the butcher in dressing a beef carcass, or by making a longitudinal incision into the "fel" along the anterior border of the tensor fascia lata.

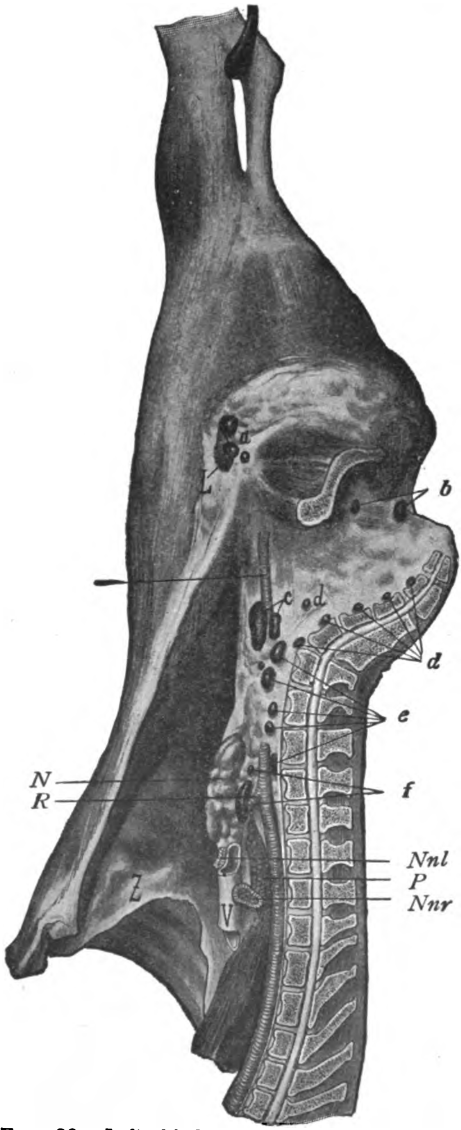

FIG. 32.—Left hindquarter of bull, internal view. *a*, Superficial inguinal lymph glands; *b*, anal lymph gland; *c*, internal iliac lymph glands; *d*, sacral lymph glands; *e*, sublumbar lymph glands; *f*, renal lymph glands. (From Edelmann's "Meat Hygiene.")

FLANK LYMPH GLANDS.

In cattle in the region of the flank there are also often a small number of small subcutaneously located glands which receive lymph from the surrounding superficial region. Their efferents pass to the precrurals or to the circumflex iliacs, which are quite near but on the other side of the abdominal wall.

THE SUPERFICIAL INGUINAL AND SUPRAMAMMARY LYMPH GLANDS.

The superficial inguinal lymph glands are located in male animals at the neck of the scrotum beside the penis in front of the inguinal ring; in castrated males they are embedded in the scrotal fat (cod fat). (See fig. 32, *a*.) In cows these glands are situated bilaterally at the postero-superior part of the mammary gland and are known as the supramammary lymph glands. (See Pl. XXX, 21.) In hogs the supramammary lymph glands are located relatively as in cattle, there

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being one or more nodes on each side situated posterior to the last segment of the compound mammary glands. (See Pl. XXXI, 5.) Occasionally all or a portion of them are removed when the hams are "faced" on the killing beds, although usually they remain and are found, in the hanging carcass, embedded in fat on a line drawn laterally from the anterior border of the pubis.

The afferent vessels are received from the posterior abdominal wall, the thigh, and the external genitals in the male, and from the posterior abdominal wall, the thigh, and the mammary gland in the female. The lymphatics of the mammæ are very rich and their lymph glands are among the largest of the whole body.

The efferent vessels pass to the small deep inguinal glands located in the inguinal canal and to the internal iliac lymph gland.

The supramammary lymph glands are of the utmost importance as indicating the state of health or disease of the mammary gland, and on post-mortem inspection of a food animal they should be closely examined, as primary disease of the udder is of common occurrence in hogs, cattle, and sheep, but especially in cattle. (See Pl. XXXII, 2.)

THE INTERNAL OR DEEP INGUINAL LYMPH GLANDS.

These glands are often absent but are located occasionally in food-producing animals at the site of the entrance of the inguinal vessels into the abdominal cavity on the upper border of the inguinal canal. They are very small and insignificant so far as meat inspection is concerned, but their presence has been demonstrated in young animals by injection with quicksilver. They receive some of the efferent branches of the superficial inguinals. Their efferent vessels pass to the sublumbar glands or direct to the receptaculum chyli.

The deep inguinals in the horse lie at the superior entrance of the inguinal canal surrounding the femoral vessels, and receive lymph from the posterior limb and superficial inguinal glands, while their efferents pass to the internal iliac glands or direct to the receptaculum chyli.

THE SACRAL LYMPH GLANDS.

Located along the inferior face of the sacrum, near its lateral border, these glands are very small and correspond in position to the glands lying along the spinal column in the dorsal and lumbar region. (See Pl. XXXI, 9, and fig. 32, *d*.) They receive their efferents from the coccygeal region, postero-superior sacral region, and rectum. Their efferents pass to the sublumbar glands. Along the superior surface of the rectum are numerous small glands whose efferents pass to the sacrals or sublumbar glands.

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THE EXTERNAL ILIAC OR CIRCUMFLEX ILIAC LYMPH GLANDS.

These glands are located in the angle of bifurcation of the deep circumflex iliac arteries, near the inferior border of the external angle of the ilium and bordering the iliac psoas and external border of the great psoas muscles. (See Pl. XXX, 18.)

Their afferent vessels are derived from the postero-internal walls of the abdomen, the efferent vessels of the precrural lymph glands and branches from the lateral surface of the upper part of the thigh. Their efferent vessels pass to the sublumbar lymph glands and through these to the receptaculum chyli.

In cattle this is a single gland about the size of a hickory nut and can only be reached after considerable mutilation of the carcass; consequently it is not ordinarily examined.

THE INTERNAL ILIAC LYMPH GLANDS.

In cattle this is a large heart-shaped gland 2 or more inches in diameter, located at about the upper third of the pelvic arch in the obtuse angle formed by the external iliac artery and the abdominal aorta. (See Pl. XXX, 19, and fig. 32, *c*.) In hogs there are several glands at this location which appear continuous with the sublumbars. (See Pl. XXXI, 8, 11.)

The afferent vessels are derived from the precrural lymph glands, the superficial inguinal glands, the walls of the posterior abdominal and pelvic cavities, and from the rectum, internal genital organs, urinary bladder, pelvis, and sacrum. The efferent vessels pass, some to the sublumbar glands and some direct to the receptaculum chyli.

In a hanging beef carcass this gland may be easily felt by placing the hand on the inner face of the ilium at about the upper third of the border of the pelvic arch.

THE ANAL LYMPH GLANDS.

These are very small glands, located in the fatty tissue on the floor of the pelvis laterally from the anus. (See Pl. XXXI, 3, and fig. 32, *b*.) The afferent vessels are derived from the anal region, the root of the tail, and surrounding tissues. The efferent vessels pass to the sacral and sublumbar lymph glands.

THE SUBLUMBAR LYMPH GLANDS.

These glands are located in the sublumbar region along either side of the abdominal aorta and are usually embedded in the fatty cushion bordering the large blood vessels of the sublumbar region. (See Pl. XXX, 17; Pl. XXXII, 4, 5; Pl. XXXI, 11, 13; fig. 32, *e*.)

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The afferent lymph radicles penetrate the lumbar muscular masses and the postero-superior abdominal walls. These glands also receive the lymph from nearly all the glands lying posterior to them, i. e., the internal iliac, circumflex iliac, and sacral glands, and from the internal sexual organs, lumbar vertebræ, and urinary apparatus. It will thus be seen that these are important glands, as they receive lymph from all of the lymphatic vessels of the posterior limb, pelvis, abdominal walls, and the inguinal region.

The efferent vessels pass to the receptaculum chyli lying just beneath the kidneys amid the suspensory ligaments of the abdominal visceral organs.

THE RENAL LYMPH GLANDS.

The renal lymph glands are located in cattle in the fatty tissue in the hilus of the kidney on the course of the renal artery. (See Pl. XXX.) In swine they are located on either side of the renal artery where it branches off from the aorta. These glands consist of several small nodes, usually a node anterior and two posterior to the renal artery and not far from the hilus of the kidney. The afferent vessels are derived from the kidneys. The efferent vessels pass directly into the receptaculum chyli, which lies immediately adjacent to these glands.

THE GASTRIC LYMPH GLANDS.

The gastric lymph glands are located in cattle in the folds and fissures of the divisions of the compound stomach, especially between the second and the fourth or true stomach, and on the course of the gastric blood vessels. In cattle they are sometimes called the glands of the paunch. There are also on the great curvature of the fourth stomach a number of small nodes.

In swine the gastric glands are large and three or four in number. They are located in the lesser curvature of the stomach and covered by the pancreas. (See fig. 33, *l.*)

The afferents are derived from the superficial parts of the walls of the stomach and from the submucosa of the stomach. The efferent conduits pass upward through the gastric omentum into the receptaculum chyli. A small lymph area on the fundus of the stomach of the hog passes up through the gastro-splenic ligament to the splenic lymph gland lying in the hilus of the spleen.

THE MESENTERIC LYMPH GLANDS.

The mesenteric lymph glands are located in cattle in the "ruffle fat," along the lesser curvature of the intestines in the folds of the mesentery, and consist of a continuous chain of glands from the abomasum to the cecum. (See fig. 35, *m.*) These glands are cylindrical segments and vary in size and consistence according to the

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stage of digestion, being more voluminous and containing a greater fluid content immediately after or during the digestive period.

This chain of glands in swine is very similar to those in cattle, except that the glands are much farther removed from the intestines, being about in the middle of the mesentery. (See fig. 36, *g*.)

In sheep the mesenteric glands are disposed as in cattle, but instead of there being many interrupted nodes they are long, cylindrical structures as if the glands were fused into one long, continuous mass.

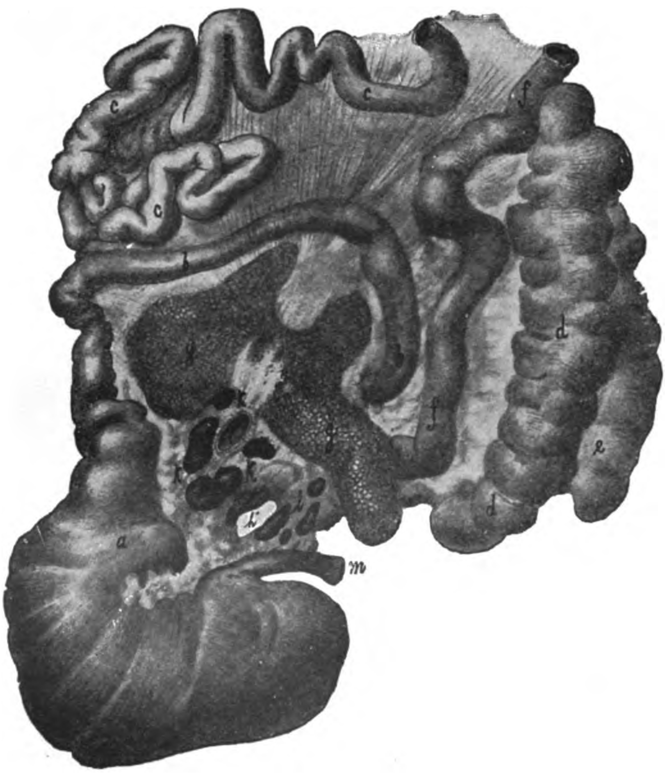

FIG. 33.—Stomach and portion of intestinal canal of hog. *a*, Pyloric portion of stomach; *b*, duodenum; *c*, jejunum; *d*, cecum; *e*, colon; *f*, rectum; *g*, pancreas; *h*, foramen of Winslow; *i*, portal vein; *k*, hepatic lymph glands; *l*, gastric lymph glands. (From Edelmann's "Meat Hygiene.")

The examination of these glands is very important in the detection of tuberculosis, as one or all of them frequently present lesions of this disease, and in quite a number of cases, especially in hogs, they are affected when no other lesions of the disease can be found in the carcass. An experienced inspector can cut into and lay open for examination a considerable number of these mesenteric glands in the hog with a few deft strokes of the knife, but some skill is required in order to throw the intestines in just the right position on the table so as to be able to make the examination quickly, which

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is very essential in the large slaughtering houses where rapid killing is the rule.

The afferent lymph radicles are derived from the very rich lymph and chyle plexuses located in the submucosa of the intestines. It is through the medium of these vessels that the chyle is transported. The chyme of the intestines furnishes the lacteals or intestinal villi with the material from which the chyle is abstracted, and this passes through these structures to the chyliferous capillary plexuses in the intestinal wall, then into the afferent vessels of the mesenteric lymph glands. The efferent vessels of these glands—sometimes called lacteals, from the milky appearance of their liquid contents—pass through the whole width of the mesentery to the receptaculum chyli.

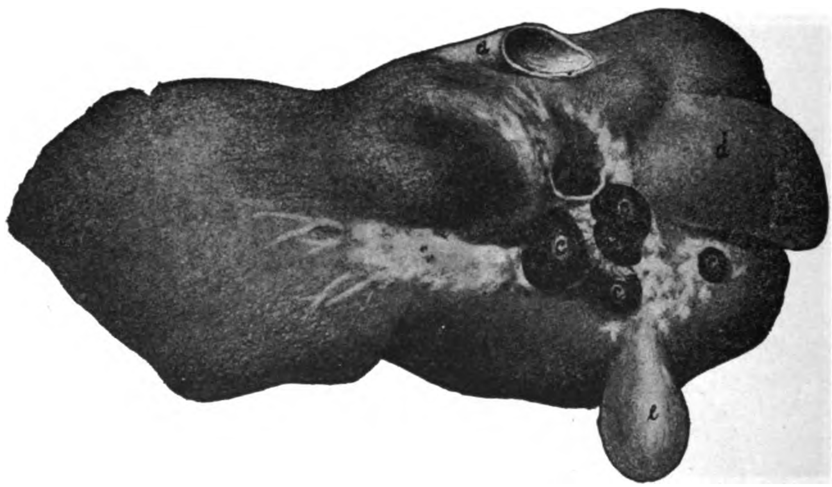

FIG. 34.—Gastric surface of the liver of cattle. *a*, Vena cava; *b*, entrance of the portal vein; *c*, portal lymph glands; *d*, lobe of Spigeli; *e*, gall bladder. (From Edelmann's "Meat Hygiene.")

Also on the colon there are a number of small lymph glands, lying in the folds, which receive the lymph from the walls of the colon and pass it on to the efferent vessels which convey it to the receptaculum chyli.

THE SPLENIC LYMPH GLANDS.

These glands are located in swine in the gastro-splenic ligament at the hilus of the spleen near the superior extremity. In bovines these glands lie at the hilus of the spleen between the folds of the splenic ligament, and when the spleen is removed the glands often remain adherent to the paunch. The afferent lymph vessels are derived from the superficial and deep portions of the spleen, and in hogs from the fundus of the stomach. In cattle also no doubt a few lymph radicles are derived from the stomach walls.) The efferents pass to the receptaculum chyli.

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THE HEPATIC OR PORTAL LYMPH GLANDS.

These glands, from three to five in number, in cattle are located on the posterior surface of the liver, embedded in the fatty cushion surrounding the vessels entering at the portal fissure. (See fig. 34, *c*.) In hogs they lie on the portal vein around the foramen of Winslow, and are usually separated from the liver during evisceration, being generally removed with the intestines, and are then readily found in the fat near the gastric lymph glands. They should invariably receive a careful examination. (See fig. 33, *k*.)

The afferent lymph vessels are from the greater portion of the anterior surface, all of the posterior surface, and from the entire

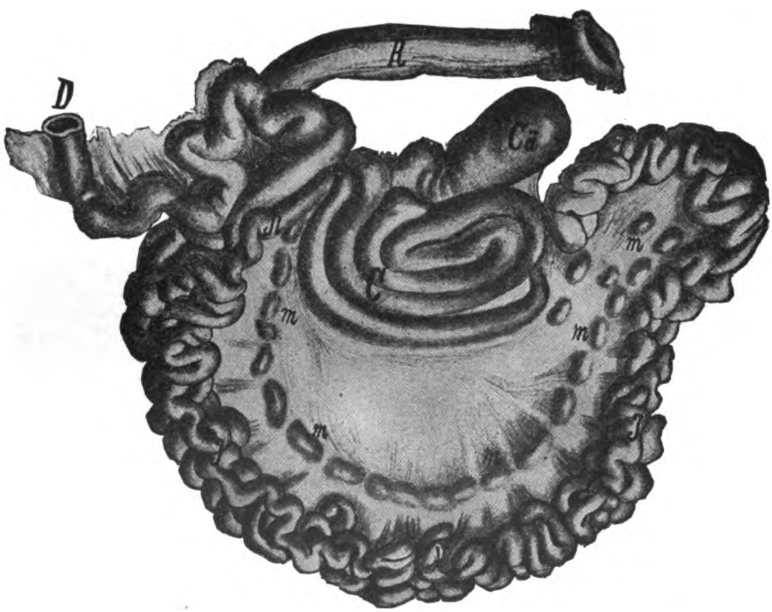

FIG. 35.—Intestinal canal of cattle spread out. *C*, Colon; *Ca*, cecum; *D*, duodenum; *J*, jejunum; *Il*, ileum; *R*, rectum; *m*, mesenteric lymph glands of the small intestines. (From Edelmann's "Meat Hygiene.")

grandular portion of the liver. The efferent vessels pass upward along with those from the stomach to empty their contents into the receptaculum chyli.

THE SUPERIOR THORACIC OR SUBDORSAL LYMPH GLANDS.

These glands are located in the intercostal spaces, embedded in the intercostal muscles and covered by the costal pleura, along either side of the dorsal vertebræ. Their afferent vessels are derived from the intercostal muscles, dorsal muscles, dorsal vertebræ, parietal pleura, and partly from the periosteum and the diaphragm. The efferent vessels pass forward and empty into the thoracic duct. (See Pl. XXX, 13.)

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In sheep and hogs these glands are absent, but a chain of lymph glands lie on the aorta just under the dorsal vertebræ. (See Pl. XXXII, 7.)

THE INFERIOR THORACIC OR SUPRASTERNAL LYMPH GLANDS.

These glands are located along the course of the internal thoracic vein and artery and are covered by the triangularis sterni muscle at the lower end of the intercostal spaces and lying superior to the sternum.

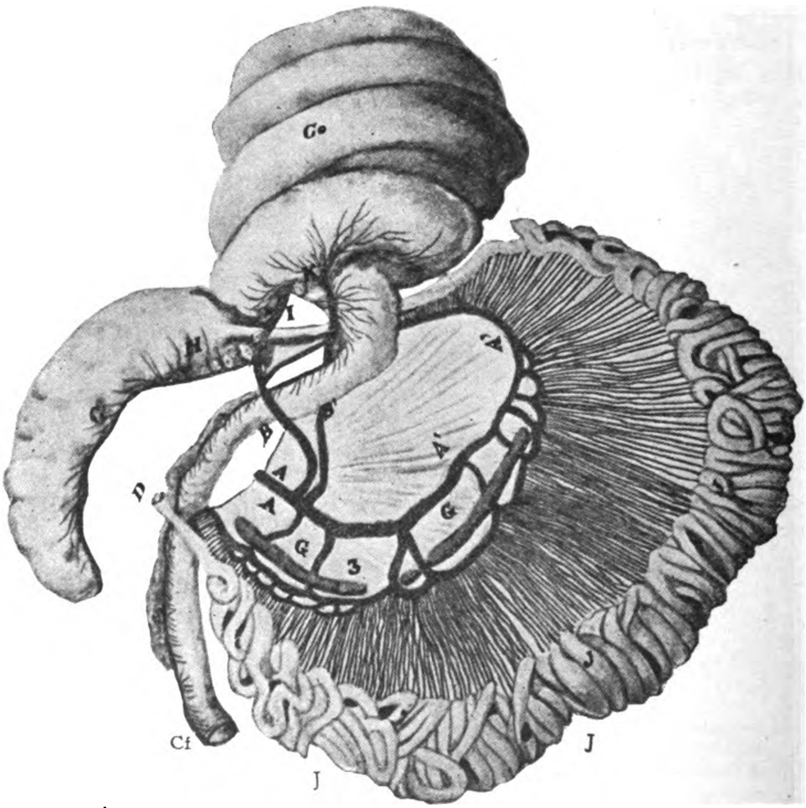

FIG. 36.—Arteries and lymph glands in the intestines of the hog. *A*, Great mesenteric artery; *A'*, arteries of the intestinal mesentery and its subdivisions; *J*, small intestines; *C*, cecum; *Co*, colon; *G*, mesenteric lymph glands forming a chain along the vascular arches of the mesentery; *H*, group of lymph nodes along the course of the cecal artery; *K*, several small lymph nodes on the colic artery. (From Aureggio's "Album Guide.")

The afferent lymph vessel are derived from the rectus abdominis, intercostal muscles, parietal pleura, and diaphragm. The efferent vessels pass to the prepectoral lymph glands in order to gain the thoracic duct, or to the thoracic duct or right lymphatic trunk direct.

It is important to note that in cattle one of the suprasternal glands is sometimes designated the sternodiaphragmatic gland, but this gland is not located in the inferior thoracic chain. It is embedded in the

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fatty tissue at the junction of the diaphragm with the sternum. Afferents are derived from pleura and diaphragm, and efferents pass to the suprasternals. (See Pl. XXX, 11, 12, and fig. 30, *a*.)

In swine the suprasternals are usually absent, but in their stead is a large single gland at the articulation of the first and second segments of the sternum. (See Pl. XXXI, 19.) In sheep there is a sternodiaphragmatic gland and a gland disposed in the same manner as in the hog, i. e., just above the first or second segment of the sternum. (See Pl. XXXII, 6, 8.)

THE LYMPH GLANDS OF THE THORACIC VISCERA.

The lymph glands of the thoracic viscera may be divided into tracheobronchial and mediastinal. The tracheobronchial glands are located on the walls of the trachea near the branching of the main bronchial tubes, which are given off to the different lobes of the lungs, and are named accordingly. The mediastinal glands are termed anterior or posterior, according to whether they are located anterior or posterior to the heart. The anterior and posterior mediastinum are not of the same significance in the human being and in cattle, sheep, and hogs. The posterior mediastinum in man corresponds to both anterior and posterior mediastinum of domestic animals. It has been thought best to designate the large gland at the anterior portion of the posterior mediastinal space as the median mediastinal gland.

The groups of glands in the region of the lungs (bronchials and mediastinals) are very important to the inspector and should be carefully examined in every case before a carcass is passed for food, as tuberculosis is frequently found in one or all of them, especially in cattle, where these glands seem to be a favored seat of infection. In sheep especially these glands often show the lesions of caseous lymphadenitis.

In hogs the bronchial glands are very well developed and are located usually in pairs in relatively the same location as in cattle. In hogs the efferent vessels pass directly to the thoracic duct.

Along the course of the phrenic nerve as it passes the base of the heart are many small reddish lymph glands embedded in the fatty tissues on either side of the nerve.

Against the pericardial sac just under the trachea is a gland which receives the vessels from this portion of the trachea and visceral pleura. Also on the visceral pleura against the inner surface of the left lung lies another small node which receives afferents from the adjacent tissues.

Dr. F. A. Imler, inspector in charge of meat inspection at Cairo, Ill., has recently called special attention to the presence in the hog of a gland, already known to some bureau inspectors, which varies in size

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from that of a small pea to that of a pecan, located between the folds of the visceral pleura and not infrequently in the lung substance on the lower median border of the lung, about 1 inch from its union with the superior median border. Its occurrence is quite variable, but usually it is found much more frequently in the right than in the left lung, and seldom a node may be present in each lung. Imler reports this gland present in from 80 to 90 per cent of all hogs, but our observations, covering several thousand hogs, show it to be present in about 12 per cent of them. It appears to receive its efferent vessels from the lung substance, mediastinal pleura, and the liver, as disease of these parts causes alterations in the glands.

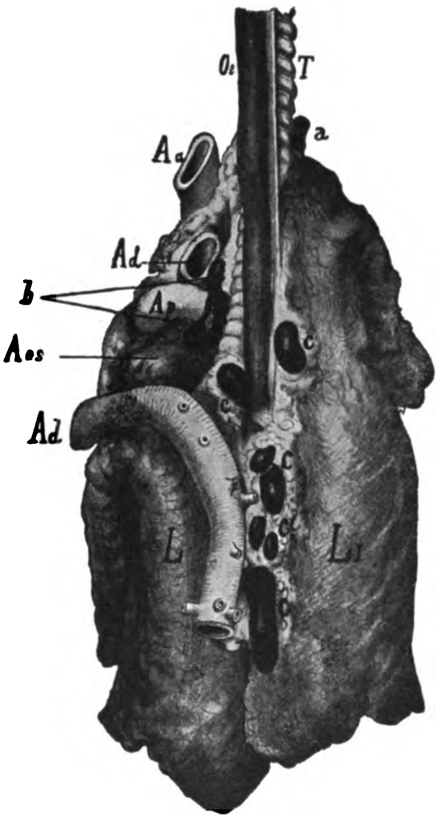

Fig. 37.—Lungs and heart of steer, suspended, dorsal view. *Aa*, anterior aorta; *Ap*, pulmonary artery; *Ad*, posterior aorta; *Acs*, left auricle; *L*, left lung; *L'*, right lung; *a*, right anterior bronchial lymph gland; *b*, left bronchial lymph gland; *c*, median and posterior mediastinal lymph glands. (From Edelmann's "Meat Hygiene.")

THE RIGHT ANTERIOR BRONCHIAL LYMPH GLAND.

This gland is located in cattle at the junction of the bronchus of the right supernumerary or cephalic lobe with the trachea, and anterior or somewhat inferior to the bronchus. (See fig. 37, *a*.) In hogs it is anterior and adjacent to the bronchus. (See fig. 38, 2.) The efferent vessels are derived from the right anterior lobe. The efferent vessels pass to the large gland located at about the middle of the posterior mediastinal region and which may be called the median mediastinal, or to the other anterior nodes of this group, then to the thoracic duct.

THE RIGHT POSTERIOR BRONCHIAL LYMPH GLAND.

This gland is located in cattle at the junction of the bronchus of the right main lobe of the lung with the trachea, and is most easily found by turning the lung bottom side up as it lies under the bronchus. For the location in the hog see figure 38, 2. The afferent

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lymph vessels are derived from the main right lobe. The efferents pass to the median mediastinal glands, thence to the thoracic duct.

THE LEFT BRONCHIAL LYMPH GLAND.

This gland is located in cattle and hogs on the left side of the trachea, anterior to and near the left bronchus, and is normally the largest of the bronchial lymph glands. (See figs. 37, *b*, and 38, 3.) It receives its afferent lymph vessels from the left lobe of the lung, and empties its efferent vessels into the anterior mediastinal glands on the way to the thoracic duct. The bronchial glands of the hog

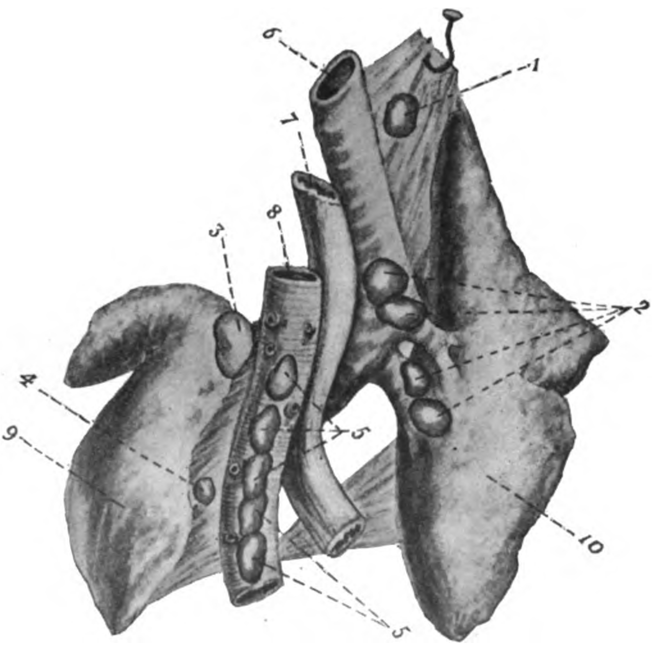

FIG. 38.—Lungs of hog, showing attached lymph glands. 1. Lymph gland on pleura adjacent to pericardial sac; 2, right anterior and posterior bronchial lymph glands; 3, left bronchial lymph gland; 4, lymph gland attached to mediastinal pleura between aorta and left pulmonary lobe; 5, lymph glands on superior face of aorta peculiar to hogs and taking place of posterior mediastinal chain of glands in bovines. (From Aureggio's "Album Guide.")

are usually found in pairs. In cattle there is usually a large single gland, rather deeply lobulated, so that it appears almost like several glands grouped together. This gland is the one ordinarily examined on the killing beds, the procedure being to grasp the anterior lobe of the left lung with one hand and with the other to make an incision across the left bronchus at the root of this lobe which cuts into and exposes the lymph gland for examination.

THE POSTERIOR OR MIDDLE BRONCHIAL LYMPH GLAND.

This gland, located at the postero-inferior part of the bifurcation of the trachea into the two main bronchi, is quite a small gland

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and is absent in some animals. (See Pl. XXX, 16.) It is always present in hogs, but on the superior part at the bifurcation of the trachea. Afferents are received from the mediastinal pleura and bronchi, and efferents pass to the anterior mediastinal glands.

Sometimes there are several small glands in close proximity at this location, and they probably receive lymph from the deeper lung tissues of the posterior lobes, from the parietal and visceral pleura adjacent, and from the diaphragm. Their efferent vessels pass along the internal face of the left principal lobe and empty into a small gland in the anterior mediastinum just above the base of the heart, thence forward to one of the glands at the apex of the pleural sac, or into the thoracic duct.

THE ANTERIOR MEDIASTINAL LYMPH GLANDS.

These glands are located in the folds of the anterior mediastinum in variable numbers. They are small in size and are distributed along the inferior and lateral parts of the trachea and esophagus anterior to the heart and near to the entrance to the thorax. (See Pl. XXX, 15, and fig. 30, *a′*.)

Their afferents are derived from the pleura, esophagus, pericardium, and heart, and efferents from posterior or middle bronchials, thymus, and small glands along the course of the phrenic nerves. Their efferents pass to either the thoracic duct or right lymphatic vein, or to the prepectorals before entering the large terminal lymph trunks.

These glands remain in the beef carcass as a rule after the lungs are removed, and in the dressed carcass the whole group will sometimes be found on one side after it is split, while in other cases one-half of the gland or glands will be found on each half of the carcass embedded in the mass of fat just superior to the anterior segment of the sternum.

THE MEDIAN MEDIASTINAL LYMPH GLAND.

This gland is located in cattle in the anterior part of the posterior mediastinal space, and is an anterior node of the posterior mediastinal group. It is quite well developed and is a very important gland, as it receives the efferent lymph vessels of the principal bronchial glands, as before described. The efferent vessels empty directly into the thoracic duct, with which it is in very close proximity. (See fig. 37, *c*.)

THE POSTERIOR OR CAUDAL MEDIASTINAL LYMPH GLAND.

This gland is located in cattle at the extreme posterior portion of the posterior mediastinal region and touching the pillars of the

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diaphragm. It is the largest of all the thoracic glands and of those known usually as the posterior mediastinal group. (See fig. 37, *c*.) Other nodes also are found in the posterior mediastinal group.

In hogs, along the superior surface of the aorta, are four or five small lymph glands which may be taken to represent the posterior mediastinal lymph glands as found in bovines.

The afferents are derived from the pleura of the surrounding posterior mediastinal region, the diaphragm, the esophagus, and the anterior face of the liver. The efferents pass forward to near the median mediastinal gland, then empty into the thoracic duct.

This gland is frequently left in the dressed carcass, in which case it will be found close to the diaphragm, adjacent to the pillars of this muscle, and should invariably be removed and examined, as it is a frequent seat of tubercular lesions. The anterior node of the posterior mediastinals (the median mediastinal) is also occasionally left in the carcass, where it can be found attached to the inferior dorsal muscles to the right of the aorta about opposite to the interspace between the fourth and fifth ribs. This portion of the gland is quite often erroneously considered by inspectors to be the anterior mediastinal lymph gland.

OTHER LYMPHATIC STRUCTURES.

Besides the lymphatic structures above described, there are many lymphatic tissues throughout the animal, of which brief mention should be made. In some of the organs of the body there are lymphatic cellular aggregations more or less extensive, yet hardly large enough to be classed as lymph glands.

Very small lymph glands are found along the course of the smaller bronchi in the lungs.

The spleen is very rich in lymphatic tissues which compose the Malpighian bodies that are so prominent on section of that organ and appear as small whitish nodules in the red matrix.

In the intestines the lymphatic tissues compose what are known as the solitary follicles and the agminated follicles or Peyer's patches. In the terminal part of the small intestines of the hog a Peyer's patch forms itself as a band 4 or 5 feet in length.

In the mucous membranes of other parts also are many lymph follicles, as in the soft palate and the base of the tongue, but particularly in the tonsils and in the posterior nares.

In the way of lymph cavities, it may be well to call attention to spaces surrounding blood vessels of the brain, known as perivascular lymph channels, and around nerve trunks, called perineural lymph sheaths; but these spaces are not dependents of the large lymph system.

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The pleural and peritoneal cavities are both thought to be in open communication with the lymph vessels; in the case of the pleura these openings occur in the intercostal spaces, and in the case of the peritoneum on the pillars of the diaphragm. The openings of communication are called stomata. Normally, these cavities contain only sufficient lymph to lubricate the contained viscera.

Stroh has recently recorded the presence of a small lymph gland in cattle at about the juncture of the xiphoid cartilage and the cartilage of prolongation of the last rib.

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THE PREPARATION OF HOG CHOLERA SERUM IN HUNGARY.

By Adolph Eichhorn, D. V. S.,
Bacteriologist, Pathological Division.

INTRODUCTION.

Many hog breeders and feeders have been discouraged to such an extent by the severe losses sustained by the ravages of hog cholera that they have hopelessly given up an industry which in the absence of this disease would be highly profitable and advantageous to them. For many years this disease has caused heavy losses in the United States, estimated at from $10,000,000 to $50,000,000 annually. Estimates by the Bureau of Statistics of the United States Department of Agriculture place the losses of hogs from disease in 1909 at $19,000,000, and it is believed that hog cholera is the cause of at least four-fifths of this loss. From these figures it can readily be seen that it is to the interest of those concerned in the live-stock industry to do everything in their power toward the control and eradication of this disease.

But the losses are not confined to the hog breeders of the United States. Hog cholera has also done great damage to the hog industry of many of the European countries. Particularly is this true of Hungary, a small country which is especially dependent on agriculture and live-stock breeding. The hog industry, until the appearance of hog cholera in that country, was one of the principal sources of revenue, but since the first appearance of this disease in 1895 an annual loss of many million dollars has been sustained and the industry has been practically ruined.

It is therefore natural that any steps made toward the control of this disease in any part of the world have been eagerly watched in that country. Thus, immediately after the news had crossed the Atlantic of the great discovery by Dorset and his associates in the Bureau of Animal Industry by which the cause of hog cholera was demonstrated and a successful method of immunization developed, the Government of Hungary undertook the establishment of laboratories and a plant where serum could be prepared on a large scale to provide for the entire demand of the country, with the object of restoring the flourishing industry of former times.

During the summer of 1910 the writer had the privilege of visiting this establishment and making a study of the conditions, equipment,

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and method of preparation of the serum. He was there long enough to satisfy himself of the splendid results that are being obtained, and is satisfied that during the two years since the serum institute was established many thousands of hogs have been saved.

LOCATION OF THE ESTABLISHMENT.

The establishment is located in a suburb of Budapest, known as Köbanya, on a part of the ground which was used for many years for the fattening of hogs. Köbanya was the principal feeding place for hogs until 1895, when this industry received a severe blow by the appearance of hog cholera, which until that time was unknown in Hungary. These feeding yards cover an area of over 500 acres, and are conducted by a corporation, which undertakes the fattening of hogs for individual hog breeders or speculators. Before the appearance of hog cholera the number of hogs fed there annually varied between 400,000 and 500,000; now, however, the number hardly ever exceeds 200,000. The breed is principally the Hungarian "Mangolicza," which is a lard-producing hog, the average weight after fattening being 600 pounds. Beside this breed the Yorkshires and Berkshires are also in prominence, although in less favor, on account of their more delicate constitution, as they are less resistant to disease and climatic exposure.

The hogs are brought to the feeding yards as a rule when 1½ years old, and the fattening and finishing process takes 9 months. The feeding is followed in a very systematic way, in which the time of the feeding as well as the quantity of feed varies with the progress of the fattening. The feed consists of corn-meal mash and dry corn.

A part of this establishment, an area of about 6 acres, has been rented to the Government for the preparation of hog cholera serum. This ground is surrounded by a brick wall, and has only one entrance. A laboratory consisting of 4 rooms has been erected on the ground at its entrance, and immediately adjoining this building is the shed in which the inoculations are made, and here also the blood is drawn from the hogs to obtain the serum. Besides the laboratory there is a smaller building which consists of 2 rooms. In one of these the hyperimmunized hogs are bled, while in the other the carcasses are eviscerated and dressed.

The ground is divided into two parts by an alley which runs through the center. On both sides of this alley pens are located. The ground is well paved with brick, and any part of the premises can be readily washed and disinfected if so desired.

ORIGIN AND GROWTH OF THE SERUM ESTABLISHMENT.

After confirming the work of Dorset and his associates regarding the etiology of hog cholera, Prof. F. Hutyra, director of the Royal Veterinary School, undertook laboratory experiments for

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immunization according to the method of Dorset. The results were satisfactory to such an extent that Prof. Hutyra undertook the serum preparation for application in practice. For this purpose he applied to the department of agriculture for funds, and it was then decided to establish a serum institute, as suggested by him, in which the necessary quantity of serum could be produced to supply the entire demand of the country. Thus, in the early part of 1909 the work was started on a small scale. By July about 450 animals were employed for the production of the serum, and this number remained stationary until December, when it was raised to 560; and from that time the number was gradually increased until in April, 1910, the total number was 1,400 hogs. This number now remains almost stationary, proving sufficient for producing the necessary quantity of serum.

In 1909 the total production of serum amounted to 609,363 c. c. of defibrinated blood and 318,517 c. c. of serum. During 1910 the monthly output of serum amounted to 260,000 c. c., the serum dose being only one-half of the quantity of the dose of defibrinated blood.

The institution aims to have always on hand a supply of serum, and during its existence there has been but one instance when, for a few days only, it was impossible to comply with the requests which came in.

METHOD OF PREPARING THE SERUM.

The process followed in the preparation of the serum is essentially that devised and described by the United States Bureau of Animal Industry, but the Hungarian workers have introduced modifications of the details and have devised certain pieces of apparatus, a description of which will doubtless be of interest to persons engaged in the preparation of the serum in the United States and elsewhere.

PREPARING HYPERIMMUNIZED HOGS.

From 100 to 200 hogs of about 200 pounds weight are purchased and placed in an infected pen, where they usually contract the disease in 20 days. Formerly it was necessary to inoculate several hogs artificially with 2 c. c. of virus in order to produce the disease. This, however, is no longer practiced, as the infected pens are always sufficient to produce the disease, and the results obtained in this way are very satisfactory. After the appearance of the disease the animals are carefully watched, and the more severely affected ones are marked with paint on their backs for easier identification. Immediately after the appearance of cutaneous hemorrhages the animals are removed from the pen and bled. The virus thus obtained is then used for the hyperimmunization of hogs which have already recovered from the disease. The hogs are placed in groups in the different pens according to the progress of the process of immunization. (See Pl.

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XXXIII, fig. 1.) For the production of virus only acutely affected animals are used. The bleeding is performed in the same manner as with the hyperimmunized animals when they are bled to death.

The table (fig. 39) upon which the animals are placed for the bleeding is made of cast iron and is so constructed that the animal is placed on its curved surface and secured by one front leg being drawn backward and upward by a rope, which is then secured to a ring attached to the other side of the table. The other leg is drawn forward and tied through a hole on the front part of the table. The animal lies on the right side. The pectoral region is shaved, washed, and disinfected with 75 per cent alcohol. The specially constructed knife (fig. 40, *a*) is then introduced near the entrance of the thoracic cavity, the carotid and jugular are severed, and the blood then runs freely into the receptacle (fig. 40, *b*). The knife is about 18 inches long. The tube part is about two-thirds of

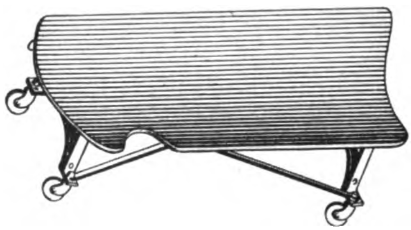

FIG. 39.—Table on which hogs are placed for bleeding.

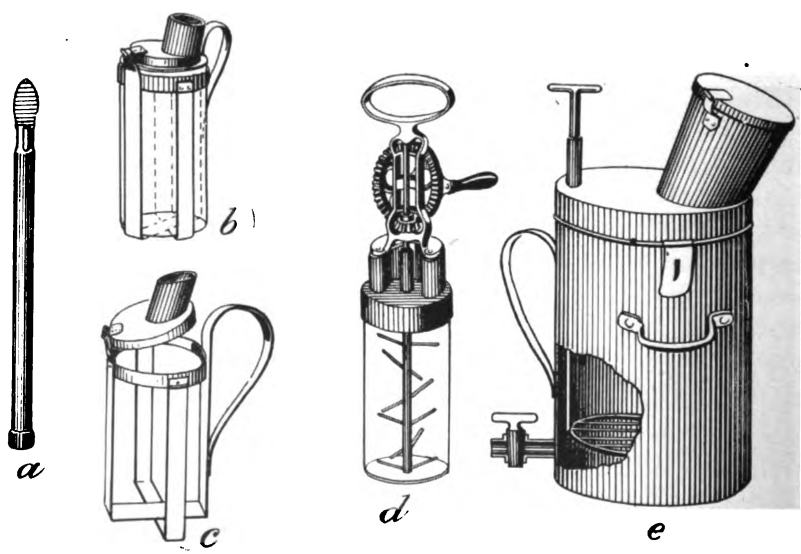

FIG. 40.—Apparatus used in bleeding hogs. *a*, Bleeding knife; *b*, receptacle (glass jar in frame) for collecting blood from tail bleeding; *c*, frame for *b*; *d*, defibrinating apparatus for blood from tail bleeding; *e*, receptacle for collecting blood from final bleeding.

an inch in diameter, and terminates in a lance-shaped cutting end. Immediately below the cutting end are openings through which blood enters the tube of the knife.

The receptacle into which the blood is allowed to flow is made of galvanized iron and has a capacity of about 1 gallon. It is supplied

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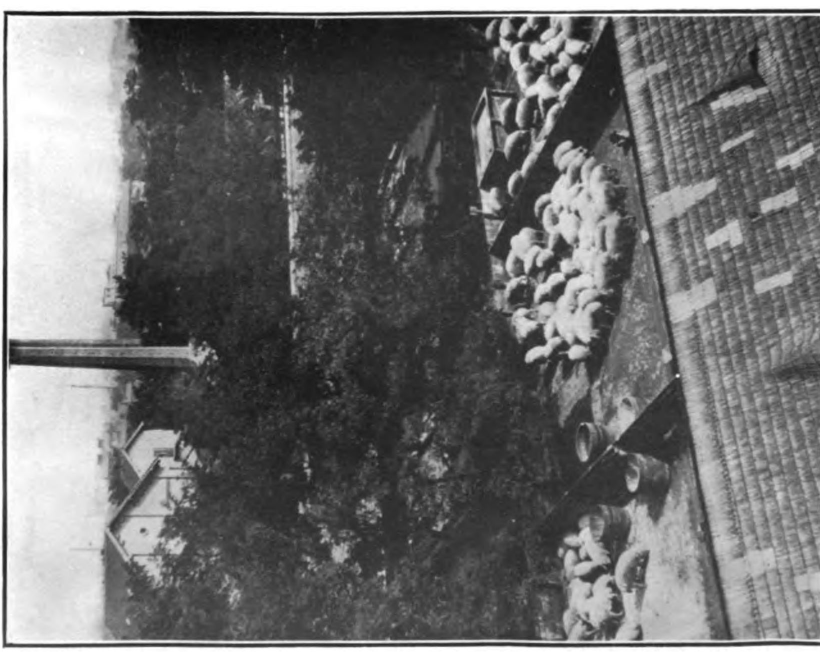

FIG. 1.—HOGS IN PENS FOR HYPERIMMUNIZATION AT HUNGARIAN INSTITUTE FOR PREPARING HOG CHOLERA SERUM.

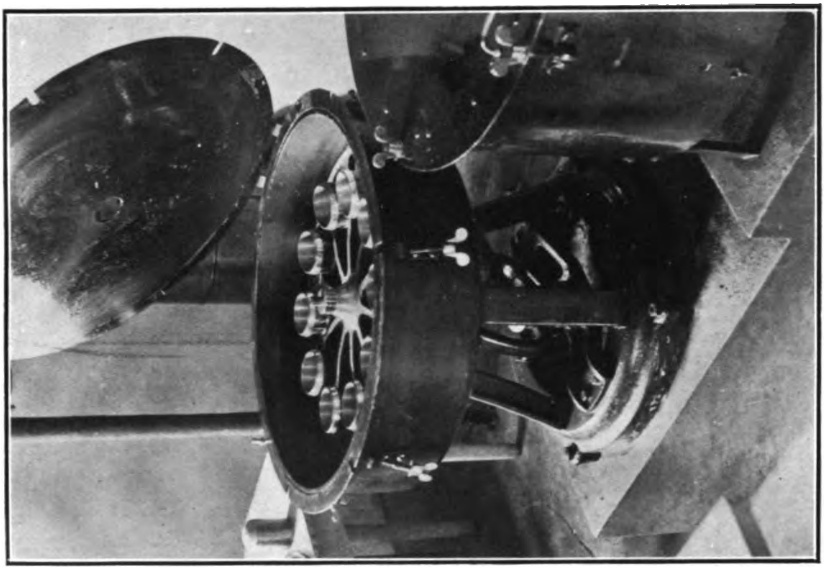

FIG. 2.—CENTRIFUGE FOR SEPARATING BLOOD CORPUSCLES FROM SERUM.

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FIG. 1.—DRAWING BLOOD FROM TAILS OF HYPERIMMUNIZED HOGS.

FIG. 2.—FINAL BLEEDING OF HOG.

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with a cover which has an extension of a metal cylinder through which blood flows into the container. It also is provided with a handle and a dasher, with the aid of which the defibrination of the blood is accomplished (fig. 40, *d*). The container at its bottom is supplied with a faucet through which the defibrinated blood is drawn off.

The blood is inoculated without much delay into the animals used for the hyperimmunization. The hyperimmunization is accomplished by three successive subcutaneous inoculations of 500 c. c. of the virus. These three inoculations are given to the recovered animals at intervals of from 10 to 14 days. Inoculations of the virus are made into the loose connective tissue of the groin, frequently on both sides. After the three inoculations the animals are bled twice from the tail, the first time 8 days after the third inoculation of virus, the second time 5 days later. The animals are again injected with 500 c. c. of virus (fourth time), in order to increase the reduced immune bodies. Eight days following the fourth inoculation the animal is again bled from the tail, and this is repeated 5 days later. In 4 more days the hyperimmunized animal is finally bled to death.

The subcutaneous inoculations of the virus are now exclusively used in the preparation of the hyperimmunized hogs. However, during the writer's visit, experiments were in progress with intraperitoneal inoculations, with the object of determining whether the quantity of virus could not be reduced and also whether the intervals between the inoculations could not be lessened.

In the preparation of the hyperimmunized hogs the large quantity of virus necessary is the principal factor, and as a result of this the production of the serum is quite expensive. This important item can be considerably reduced when hog cholera prevails in the vicinity of such a serum establishment. In that case virus can be obtained from time to time in considerable quantities from the acutely sick animals without expense. This method has been practiced at Budapest, but there have been no recent outbreaks of hog cholera in the surrounding country, and at the present time it is necessary to obtain the virus from the animals which have been made sick at the establishment.

To hold hogs for inoculation a very ingenious arrangement is used at the serum establishment. (See fig. 41.) It consists of a stall, three sides of which are stationary, the remaining side being movable and held in place by a bar. The movable side is provided with four rollers, and to the inside and lower part a wide strap is fastened. The hog enters through a door in the side of the stall into the stand, and walks with the front leg over the strap, which is allowed to hang loose on the floor of the stall. Immediately after the animal is secured the crossbar is released, the side falls down to the ground and rests on the rollers, and the animal lies secure.

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BLEEDING OF HYPERIMMUNIZED HOGS.

The hyperimmunized animals, when ready for their first bleeding from the tail, are placed on a stand made of cast iron, which consists of a stall of just sufficient size to hold a hog. (See fig. 42.)

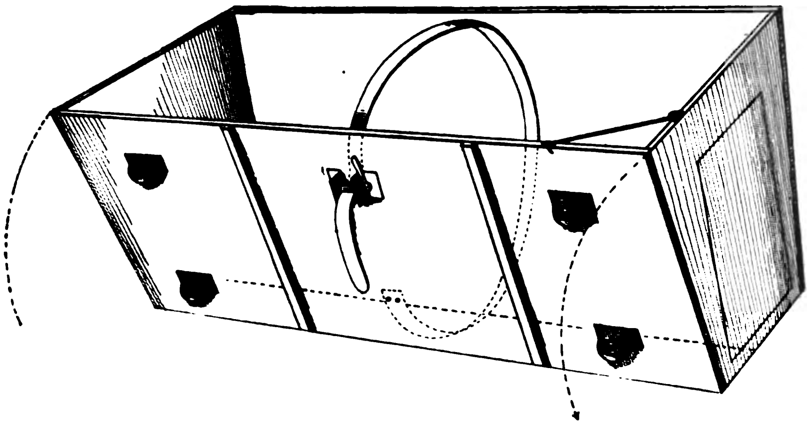

FIG. 41.—Stall for securing hogs for inoculation with virus.

These stands are provided with rollers by the aid of which they are rolled to a small door in the hogpen. Inside of this door in the pen, there is a chute through which the animals are driven through the door into the stand. The stand is provided with leather straps in the front and back, one securing the animal on the abdomen in front of the hind leg, another over the loin, while in front there is one to secure the animal in front of the shoulders. The straps are fastened by a lever with which the releasing and securing of the animals can be accomplished by a single motion. The head is also secured by passing a rope around the upper jaw and fastening it to a ring in the wall.

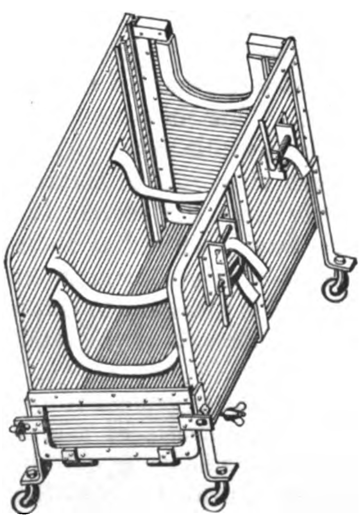

FIG. 42.—Stand for securing hogs for bleeding from tail.

After securing the animal in the stand, the hair of the tail and around its base is well clipped, and the tail is washed with hot water, disinfected with 75 per cent alcohol, and then submerged in a dish containing hot water at 50° C. for 5 to 10 minutes. The latter is done in order to produce a hyperemia in the blood vessels. Another method by which the hyperemia of the vessels is

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produced and the flow of blood hastened consists in placing an electric bulb in close contact with the tail, the reflection of the light of this bulb being directed toward the tail. However, uniformly good results are obtained from the hot-water method. After the removal of the tail from the hot water a piece is cut off, irrespective of whether a joint is struck or not. The instrument used in this operation is shaped somewhat like an emasculator, sharp on both edges, and only a slight effort is required to sever the tail. Should the flow of blood cease before a sufficient quantity is obtained the stub of the tail is rubbed with a piece of sterile cotton, and if the flow should not be renewed by this method, another piece is clipped off; and if this should fail the tail is again placed in hot water. The operation of drawing blood from the tails of hyperimmunized hogs is shown in Plate XXXIV, figure 1.

The receptacles into which the blood is received from the tail bleedings consists of a fruit jar, which fits in a framework, to which a lid is fastened to cover the jar. (See fig. 40, *b* and *c*.) This lid has a cylindrical projection and somewhat resembles the cover of a milking pail. After placing the empty jar in the frame it is covered with the lid; the blood is then allowed to flow from the tail through the cylindrical projection of the lid into the jar, and when the jar is filled it is taken from the frame. The receptacle has a capacity of about 500 c. c., and two such receptacles are filled with blood from each hog. It takes an average of about an hour to draw the desired quantity from each animal. The blood is defibrinated in the jar by attaching an apparatus consisting of a wheel with a handle (like that of an egg beater) which turns a rod to which seven crossbars are attached. (See fig. 40, *d*.) This is placed on the jar, and by alternately revolving it in each direction the clot is broken up in about one minute; then the beating apparatus is removed and the jar is covered with its regular lid.

Four bleedings from the tails are made at intervals stated above, and at each bleeding 900 to 1,000 c. c. of blood is drawn from each animal. After the conclusion of the bleeding of the animals on a particular day the blood in the jars is filtered through gauze into a large bottle, from which it can be drawn through a faucet close to the bottom.

The last bleeding, during which the animal is bled to death, is accomplished in the same manner as when the virus is drawn from an affected animal for hyperimmunization. The same kind of a knife is used for severing the carotid and jugular, and the securing of the animal is also carried out in the identical way as described in the bleeding for virus. (See Pl. XXXIV, fig. 2.) The blood is also allowed to run into a receptacle (fig. 40, *e*) in which the defibrination is carried out in a churnlike manner.

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PREPARATION OF BLOOD SERUM.

The defibrinated blood, whether obtained from the tail bleedings or from the final bleeding, is conveyed into the room where the centrifugalization takes place. There are two centrifugal machines of 7 liters capacity each (Pl. XXXIII, fig. 2). These machines have an arrangement for 10 containers of 700 c. c. each. These containers are filled with the defibrinated blood, the lid is tightly secured, and the machine is set in motion and the speed gradually increased. The power is furnished by a gasoline engine, and the machine makes 2,000 revolutions a minute.

The process of centrifugalization lasts one hour, when the jars containing the centrifugalized blood are taken out and placed on a

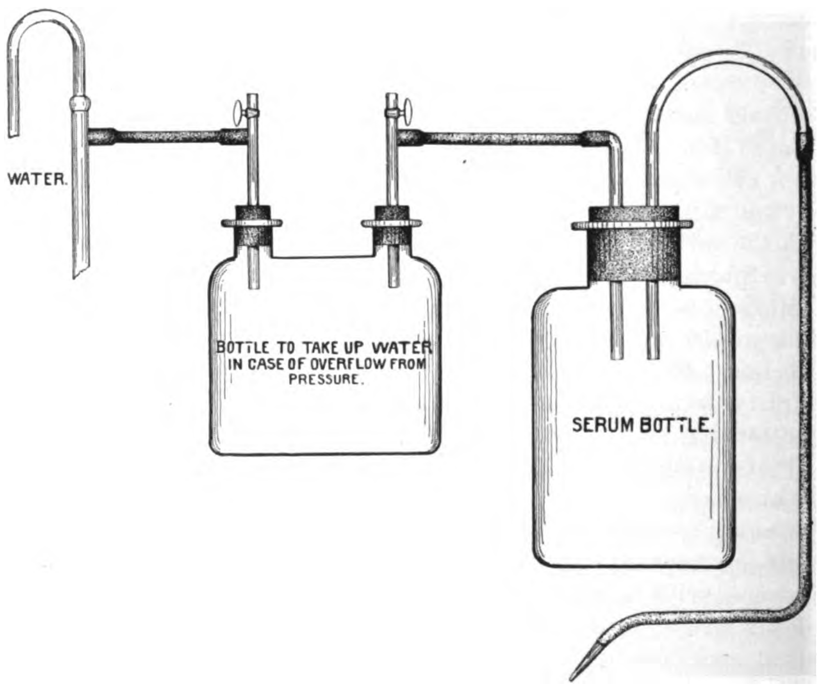

FIG. 43.—Apparatus for siphoning serum after centrifugalization of blood.

table, where the siphoning of the serum is accomplished. This is carried out with the aid of a vacuum pump attached to an ordinary hydrant pipe. From the pump a rubber attachment is made with a Woulff bottle, which serves to take up the water in case of an overflow from excessive pressure. From this bottle a rubber attachment is made with another large bottle, which serves for the collection of serum. To this serum bottle a rubber tube with a small drawing pipette is attached. This whole apparatus represents simply an arrangement by which the serum is easily siphoned off from the red blood corpuscles. This is accomplished without the slightest difficulty, and there is absolutely no loss of serum by this method. (See fig. 43.)

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To the serum thus obtained there is immediately added as a preservative 1 part of carbolic-acid solution to 9 parts of serum. The carbolic-acid solution consists of—

	Parts.
Carbolic acid	5.5
Glycerin	20.0
Distilled water	74.5

FILLING BOTTLES FOR SHIPMENT OF SERUM.

The large bottle containing the carbolized serum has an arrangement for an outflow of serum close to the bottom, to which a rubber tube is attached which connects with a graduated cylindrical container. The container holds 600 c. c., and is divided into 25 c. c. graduations. The serum is allowed to flow into this cylindrical container by opening a stopcock attached to a glass tube running from the side of the bottle. As soon as the desired quantity has flowed into the container the flow is checked by closing the stopcock. The bottom of the container connects with a glass tube to which a stopcock is also attached. With the opening and closing of this stopcock the desired quantity of serum is allowed to run into the different-sized bottles which are used for the shipment of the serum. This apparatus is illustrated in figure 44.

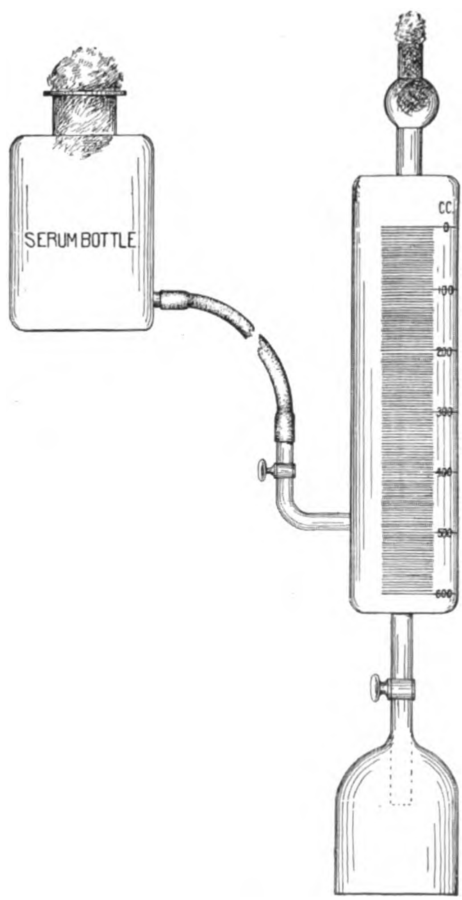

FIG. 44.—Apparatus for filling bottles with serum.

As the serum is filled into the bottles of different sizes they are temporarily plugged with cotton, and after the filling is concluded the cotton plugs are replaced with corks which have been autoclaved and submerged in hot paraffin. There are kept on hand different-sized bottles, varying from 50 to 500 c. c., filled with serum ready for shipment.

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DIRECTIONS FOR USE OF SERUM.

The following directions are sent out with the serum:

Directions for the Immunization Against Hog Cholera (Swine Plague).

The serum is obtained from artificially hyperimmunized hogs and contains 0.5 per cent carbolic acid. Inoculated into the body of healthy hogs, it produces in the majority of cases a passive immunity lasting at least three weeks, which, however, would become active should the animal immediately after the inoculation become exposed to natural infection.

The serum until it is used should be kept in a cool place (ice box or cool cellar), and should be injected under the skin on the inner surface of the ham, with a previously carefully boiled and cleansed syringe. The doses are as follows:

	c. c.
Hogs weighing under 20 kilos	8
Hogs weighing 20 to 40 kilos	10
Hogs weighing 40 to 60 kilos	13
Hogs weighing 60 to 75 kilos	15
Hogs weighing 75 to 90 kilos	20
Hogs weighing over 90 kilos	25

Inasmuch as the inoculation protects the animals only for a short period, it should be employed in infected herds where hog cholera (swine plague) has appeared only very recently or only in cases where the healthy herd is threatened by danger of immediate infection.

In such herds it is advisable to inoculate all the animals with the exception of those which are already severely affected, and it is best to slaughter such animals as soon as possible.

From the inoculations good results can only be expected at the onset of the infection; therefore, if in a herd many deaths have occurred, and if 20 to 25 per cent of the animals are sick, then it may be readily seen only little success can be expected.

It is advisable to retain the herd in the infected place until the infection has entirely passed off. In the meantime it is advisable to isolate those animals which show the characteristic indications of the disease (lack of appetite, dullness, diarrhea, exudate from the eyes, etc.).

If the inoculation does not check the infection in from one to two weeks, it can be repeated.

Besides these directions, there is also sent to the veterinarian a printed blank to be filled out and returned so as to furnish the establishment with statistical data on the results of the inoculation. These reports are used in compiling the annual reports of the serum institute.

RESULTS OF PRACTICAL USE OF SERUM.

The results of the inoculations in 1909 are compiled in the following tables, and from these it can be readily seen that the mortality in all the inoculated herds averages only between 8 and 9 per cent. Of course it should be taken into consideration that in numerous instances the serum has been applied in badly infected herds where

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the infection existed in more than 25 per cent of the animals before the inoculation. Prof. Hutyra showed the writer numerous reports of cases in which the serum had been employed at the onset of the outbreak, and in most of these instances the infection was abruptly checked without any further loss of animals.

Inoculation of apparently healthy animals in infected herds.

Deaths.	Inoculated.				Not inoculated.		
	Number of herds.	Number of animals.	Deaths.		Number of animals.	Deaths.	
Per cent.			*Number.*	*Per cent.*		*Number.*	*Per cent.*
0	18	2,237	0	0	573	91	15.9
0.1- 5.0	12	2,442	56	2.3	1,122	147	13.1
5 -10.0	3	498	42	8.4	509	104	20.4
10 -20.0	9	1,816	226	12.4	1,203	710	59.0
20 -30.0	4	707	167	23.6	328	111	33.5
30 -40.0	3	576	220	38.2	136	86	63.4
42 -63.0	5	872	513	58.8	509	269	53.6

Results of protective inoculations against hog cholera.

Number of herds.	Number of animals inoculated.	Deaths.	Total deaths.	
		Per cent.	*Number.*	*Per cent.*
85	6,177	0	0	0
27	5,335	0.1- 5	107	2.0
11	2,316	5.0-10	179	7.7
17	3,364	10.0-20	483	14.3
9	1,149	20.0-30	281	24.4
7	869	30.0-40	308	35.4
6	879	42.7-62	516	59.0
162	20,089	....	1,876	9.3

The results are about uniform in all the reports, which in all cover over 250,000 animals. The average mortality in the inoculated herds remains stationary, about 8 to 9 per cent.

SELECTION OF HOGS FOR THE PRODUCTION OF SERUM.

Experiments were conducted with various breeds of hogs such as the Hungarian Mangolicza, Yorkshire, Berkshire, and Poland-China. While the quality of the serum proved in all instances satisfactory, nevertheless the quantitative production of the serum from these different breeds varied, particularly from the tail bleedings. The amount of blood which could be obtained was considerably less in the English breeds than in the Mangolicza. This can be principally attributed to the thin and wiry structure of the tail in the English breeds, while in the Hungarian breeds it is much thicker and looser. Besides, the constitution of the finer bred hogs is more delicate, and they do not stand rough handling in the attempt to secure them for the different operations as well as the tougher Hungarian breed.

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During the preparation of the hogs for the production of serum they are fed only lightly, as it is desired that they should not become fat, but at the same time that they should remain in good condition. The food which they receive consists of 10 parts of ground corn and 3 parts of bran mixed with water. In addition to this, ordinary dry corn is also given.

EXPERIMENTS WITH THE SIMULTANEOUS METHOD OF INOCULATION.

On inquiry as to whether the so-called simultaneous method of inoculation (i. e., the simultaneous injection of virus or blood of diseased hogs and the serum) is applied in Hungary, the writer was informed by Prof. Hutyra that this method had been tried and that the recent results were highly satisfactory. The first experiments in the latter part of 1909 were very unsatisfactory; as the result of this simultaneous inoculation 18 to 20 per cent of the animals died. Since then, however, the dose of the virus has been reduced to 1 c. c., and the results have been very gratifying, and this method of immunization has been used in practice on over 3,000 hogs. This work is under the direct supervision of the serum institute. In recent work only 3 animals died, which constitutes about 0.1 per cent of the number inoculated.

DISPOSAL OF MEAT OF HOGS USED IN SERUM PRODUCTION.

The carcasses of hogs used in the production of serum are disposed of in accordance with the regulations in existence for the disposal of carcasses affected with hog cholera (swine plague).

Those carcasses which supplied the blood used for the production of virus and which were killed in the acute stage of the disease are judged by the extent of the lesions existing in the carcass. Thus, if the septicemic lesions are of such a character as would demand condemnation according to the regulations, the carcass is condemned. However, if the lesions are more or less confined to the skin or affect only slightly the visceral organs, the animals are passed for meat of inferior quality which is then sold under declaration of its quality.

On the other hand, all carcasses which were hyperimmunized are passed for food without any restrictions. This, of course, reduces considerably the expense of the production of the serum.

PRICE OF SERUM, ETC.

The institute charges for the serum a price of 1 crown (equivalent to 20 cents in American money) per dose. This price is said to be sufficient to cover the expense of production, and on this basis the institute can be conducted without any great deficit.

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The staff of the serum institute at Budapest consists of three veterinarians, one of whom is in charge of the establishment, and three assistants who are laboratory helpers. Seven men perform the work of laborers.

It is gratifying not only that the work of the Bureau of Animal Industry regarding immunization against hog cholera has been confirmed by the Hungarian scientists, but that the discovery is being utilized successfully in protecting and restoring the hog-raising industry in Hungary.

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PRIMARY SPLENOMEGALY IN SHEEP.

By L. Enos Day, V. S.,
Veterinary inspector in charge of branch pathological laboratory, Chicago, Ill.

INTRODUCTORY.

During the past quarter of a century a very limited literature has sprung up dealing with the very interesting pathological process known as splenomegaly in man. Splenomegaly as a distinct pathological process was first described by Gaucher[1] in 1882, and afterwards by Picou and Ramond,[2] Collier,[3] Bovaird,[4] Brill, Mandlebaum, and Libman.[5] These writers describe the affection as a chronic slow-progressive disease of early childhood, usually affecting young girls under 6 or 7 years of age. One of the cases reported by Brill, Mandlebaum, and Libman was, however, first noticed in a young man 19 years of age.

The first symptoms usually observed in children are enlargement of the spleen and liver; in some of the cases reported there was an enlargement of the tonsils and axillary and inguinal lymph nodes. During the early stages of the disease the appetite is usually good and excretions are apparently normal. During the latter stage of the disease the abdomen becomes very much enlarged, the enlargement being due to the enormous size of the spleen and liver, and there are general emaciation, light-yellow or brown pigmentation of the exposed skin, more especially over the nose and temporal bones, constant constipation, and frequent epistaxis.

The most marked changes on post-mortem are found in the spleen, the liver, and the mesenteric lymph nodes. The spleen is enormously enlarged; in Bovaird's case the spleen measures 34½ cm. from above

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[1] Gaucher, P. C. E. De l'épithelioma primitif de la rate. Hypertrophie idiopathique, de la rate, sans leucémie. Thèse pour le doctorat en médecine. 31 pp. Paris, 1882.

[2] Picou, Raymand, and Ramond, Felix. Splénomégalie primitive. Epithélioma de la rate. Archives de Médecine Expérimentale et d'Anatomie Pathologique, tome 8, No. 2, pp. 168–185. Paris, March, 1896.

[3] Collier, William. A case of enlarged spleen in a child aged 6. Transactions of the Pathological Society of London, vol. 46, pp. 148–50. London, 1895.

[4] Bovaird, jr., David. Primary splenomegaly—Endothelial hyperplasia of the spleen. Two cases in children—Autopsy and morphological examination in one. American Journal of the Medical Sciences, new series, vol. 120, No. 4, pp. 377–402. New York and Philadelphia, October, 1900.

[5] Brill, N. E., Mandlebaum, F. S., and Libman, E. Primary splenomegaly—Gaucher type. Report on one of four cases occurring in a single generation of one family. American Journal of the Medical Sciences, new series, vol. 129, No. 3, pp. 491–504. New York and Philadelphia, March, 1905.

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downward, 20 cm. from behind forward, and 11 cm. from without inward, and weighed 12½ pounds. The liver is also enlarged, in some cases weighing as much as 10 pounds. The mesenteric lymph nodes are enlarged, pale, and edematous.

On microscopical examination the spleen lesions are found to consist largely of an excessive proliferation of the endothelial cells of the pulp. These endothelial cells are usually large and of varied size and shape, measuring from 20.8 to 57.2 microns in diameter. In some places these cells lie free in spaces, while in others they are associated with fibrous hyperplasia. Similar endothelial hyperplasia occurs in the mesenteric lymph nodes and in the connective tissue of the liver.

This condition, so far as the writer has been able to determine, has not been reported as occurring in the lower animals

OCCURRENCE OF THE DISEASE IN A SHEEP.

During the month of December, 1909, the writer received for diagnosis from one of the large slaughtering establishments in Chicago an enlarged spleen and liver from a sheep. After sections from the spleen and liver were prepared and examined microscopically it was found that the changes in the tissue were so characteristic of those described in primary splenomegaly in man that a diagnosis of primary splenomegaly was made.

POST-MORTEM EXAMINATION.

The above organs were removed from a female sheep 3 or 4 years of age, which was very thin in flesh, although no symptoms of disease were observed on ante-mortem. On post-mortem the spleen was found to be very much enlarged and loosely attached to the adjacent viscera by fibrous tissue bands. It was spherical in shape and weighed approximately 8 pounds. On closer examination after arrival at the laboratory it was noted that the greatest enlargement was at the hilus, the enlargement extending into the substance of the organ to within an inch of the lower extremity and involving the remaining portion, giving it the appearance of a slightly flattened sphere. Its longest diameter, which was from above downward, measured 20 cm., and from the hilus outward 18 cm. The lower extremity of the spleen was normal in thickness for about 3 cm., when it expanded very abruptly and became entirely lost. Upon the surface of the organ were many fibrous adhesions which were divided when it was removed, except over the diaphragmatic surface, which was firmly attached to the diaphragm.

The capsule was very much thickened and fibrous over the enlarged portion. Where it was in contact with the diaphragm the

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capsule was ½ cm. thick, while the remainder was from 1 to 2 mm. in thickness. The surface was mottled in color, light to dark gray, the color depending upon the thickness of the fibrous capsule. On section the appearance of the organ varied greatly in different parts. In the center it was yellowish gray in color and quite firm and resistant. This condition extended to within about 4 cm. of the periphery. The center was made up principally of a meshwork of fibrous tissue, which contained here and there small islands from ½ to 1 cm. in diameter which were composed of a reddish-brown substance resembling splenic tissue.

The periphery was reddish brown in color, pultaceous in character, resembling normal splenic tissue, which was divided into small areas from 3 to 15 mm. in diameter by bands of fibrous tissue extending from the central portion to the thickened capsule.

The liver was normal in size and general shape. On the surface were many irregular, bosselated areas, from ½ to 6 cm. in diameter, which were dark brown in color and slightly softer than the surrounding tissue. These areas were more numerous in the right and Spigelian lobe than in the left lobe of the liver. Aside from these changed areas the color and texture of the viscus appeared normal.

On section the smaller areas were slightly pultaceous in character and reddish brown in color. The centers of the larger areas were dark gray in color, firm and fibrous, peripheries of the larger areas were reddish brown in color, quite soft, and were divided into small masses by fibrous bands extending from the fibrous center to the periphery.

Viewing the cut surface of one of the largest areas of the liver as a whole, its appearance was very similar to that of the spleen, only, of course, much smaller, as those areas were only about 6 cm. in diameter.

MICROSCOPIC APPEARANCE.

Sections were taken from the center and from the periphery of the spleen, also from several of the changed areas in the liver. They were fixed in Zenker's fluid and in formalin, and embedded in paraffin or celloidin, and stained with hematoxylin and eosin.

Sections from the outer part of the spleen have a very different appearance from those of the central part. Nearly all of the central part, which will be described more fully later, is necrotic. The outer part of the organ consists of large, irregular, oval, or polyhedral spaces, some of which are filled with blood, others with blood and large, brightly staining cells, resembling endothelial cells. These cells have a moderate amount of protoplasm. The largest cells measure from 21.84 to 24.96 microns in diameter, and the smallest from 8.39 to 9.36 microns in diameter. The nuclei contain a large

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amount of chromatin, and stain deep with hematoxylin. The largest are from 10 to 15.6 microns in diameter, the smallest 6.39 microns in diameter. The smallest cells are mononuclear, many of the largest cells have two nuclei, and many have nucleoli. The spaces are surrounded by fibrous connective tissue. In many places fibrous connective tissue bands extend across the larger spaces, dividing them into smaller spaces. Scattered through all of the changed tissue are deposits of dark pigment. Sections were tested for iron according to Stieda's method, but only a trace was found. Sections from the lighter colored central portion of the spleen, which did not contain any of the small reddish-brown areas, have become necrotic. This portion of the organ is made up largely of fibrous tissue which surrounds small islands of splenic tissue. These areas are from ½ to 2 mm. in diameter, and are made up of loosely formed recticular tissue, with meshes varying from 0.089 to 0.8 mm. in diameter. Many of the meshes contain large degenerated cells, others contain blood spaces. All of the cell nuclei in the necrotic areas stain very pale, and in most places it is very difficult to make out the outlines of the cells or their nuclei. Scattered through this necrotic tissue are deposits of dark pigment, which in places is collected in small masses; in other parts it appears as very fine granules, which are quite evenly distributed.

The dark-colored islands which are scattered here and there through the central portion of the spleen have the appearance of changed Malpighian corpuscles. At or near the center of these areas is an artery with moderately thick walls. Collected around this artery are many large endothelial cells like those described in the periphery of the enlarged spleen. Lying between the large cells are a few lymphocytes, also red blood corpuscles. There is quite a wide space which is filled with blood between the outer margins of the changed areas and the necrotic tissue.

Sections from the small altered areas in the liver showed the same change as those described in the outer portion of the spleen. The periphery of the larger areas corresponded with that of the spleen, while the dark-gray central portion corresponded in structure with the central portion of the spleen, which had become necrotic. The hepatic lymph nodes showed a hyperplasia of the connective-tissue elements, but otherwise they appeared normal.

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OUR PRESENT KNOWLEDGE OF THE DISTRIBUTION AND IMPORTANCE OF SOME PARASITIC DISEASES OF SHEEP AND CATTLE IN THE UNITED STATES.

By Maurice C. Hall,
Assistant Zoologist, Zoological Division.

IMPORTANCE OF PARASITIC DISEASES.

The importance of diseases due to animal parasites is not generally appreciated. This is largely due to the fact that the diseases and the parasites are not well understood. The parasitic diseases with which people in general are familiar are those due to bacteria. It is understood that bacteria, though omnipresent, are very small, and that certain apparatus is necessary in order to see them. No such understanding exists in the case of the worm parasites, and since these do not intrude themselves on the attention of the casual observer it seems to be more or less assumed that these parasites are comparatively rare, that they are of importance only to the specialist or to persons geographically remote. As a matter of fact, parasites which are comparatively common and large enough to be readily seen may be easily overlooked unless looked for, and looked for intelligently.

One reason why people in this country fail to understand the nature and importance of parasites is that there are so few students of the subject in the United States. Not only are there few American specialists in this field, but our physicians and veterinarians pay less attention to this subject than do the European physicians and veterinarians. It follows, here as elsewhere, that where there is a lack of accurate information there is an abundance of inaccurate belief, among others a belief in the infrequency and harmlessness of parasitic infection. A feature which favors this condition of affairs is the fact that infection with worm parasites can hardly be detected in many cases on the basis of definite clinical symptoms, as bacterial diseases can, but depends for its detection on the findings of fecal, urine, blood, and sputum examinations, or even the examination of the flesh, as in the case of infection with trichinæ or certain bladder worms.

It is encouraging to note that while we are still far from a general appreciation of the importance of parasitic diseases, there is, nevertheless, a growing appreciation. In this country an increasing knowledge of this subject is to some extent merely our part of the growing

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understanding of the world. The unusually large part which parasites play in the field of tropical medicine has compelled physicians and veterinarians everywhere to pay some attention to this allied branch of zoology. In our own country the scientific interest of such workers has been given point by our acquisition of Porto Rico and the Philippines, by the work against malaria and yellow fever, and by the educational campaign against the hookworm in the Southern States. The United States Department of Agriculture, the State experiment stations, and the farm and stock periodicals have insisted on the importance of the stomach and nodular worms of sheep until the farmer and stockman have become acquainted with them as facts, even if they still fail in many cases to know the things themselves.

These parasites which are to some extent known are but a small part of the total number which affect man and the domestic animals. The two hosts which are to be considered in this paper, the sheep and the cow, are afflicted by a large number of parasites. These parasites are external and internal. Some cause only a comparatively slight annoyance or physiological disturbance; others, unless interfered with, will kill every animal attacked by them. They include numerous species of protozoa (one-celled animals), trematodes (flukes), cestodes (tapeworms), nematodes (roundworms or threadworms), insects, and arachnids (mites and ticks). The Texas-fever parasite, *Piroplasma bigeminum*, is the most important protozoan parasite of cattle in this country. There are no protozoan parasites of sheep in the United States that are known to be of importance at present. Our cattle are infected with at least three flukes and our sheep with two; two of these are of known importance. Our cattle are infected with three larval and two adult tapeworms, and our sheep with three larval and four adult tapeworms. According to Ransom [1] (1911), the digestive tract of American sheep is infested with 22 [2] nematodes and that of the cow with 12. Other nematodes infest the lungs, body cavity, etc. Numerous flies and lice attach themselves temporarily to our cattle and sheep, and some of the flies pass their larval stages within their bodies. A number of ticks attack American cattle and sheep, one of them being the carrier of the Texas-fever parasite of cattle, and there are a number of mites which cause the several varieties of scab and mange in the sheep and the cow.

Any one parasite may occur on or in an animal in such numbers or under such circumstances as to cause severe injury or, in many

[1] References to literature may be found in the bibliography at the end of this paper or in Bureau of Animal Industry Bulletin 39, "Index-Catalogue of Medical and Veterinary Zoology." Only references not appearing in the Index-Catalogue are given in the bibliography.

[2] A new species, bringing up this total to 23, has been discovered in Colorado sheep by the writer.

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cases, death. Thus the Texas-fever parasite multiplies in the blood of cattle to a point where it often causes death. Liver flukes obstruct the flow of bile, destroy the liver tissue, and very commonly kill the infected animals. The gid parasite destroys the brain tissue and thereby injures the nervous mechanism to the point where the sheep is no longer able to eat and spends its time in a monotonous and continuous repetition of some automatic or reflex action until it dies of starvation or the cessation of some vital activity dependent on some injured brain part. Nematode parasites of the digestive tract of sheep frequently occur in large numbers. The writer has collected 3,915 stomach worms and 981 hookworms from one sheep and 4,350 stomach worms and 296 hookworms from another. There are often thousands of such small nematodes as *Strongyloides* in the sheep, and yet such an infection will be easily overlooked unless carefully searched for. As many as 60 to 80 grubs of the sheep gadfly, *Œstrus ovis*, have been taken from the head of a sheep. Such massive infections with grubs or nematodes can not fail to result in injury or even death. Even relatively light infections are apparently sufficient to cause the death of an animal under adverse weather conditions or during periods when food is scarce, while uninfected or less infected animals manage to survive.

DESIRABILITY OF A STUDY OF DISTRIBUTION.

It is highly desirable that we should know the distribution of a parasite. Knowing the distribution, we would have valuable data as to its economic importance. We would know whether it is of local or limited importance, or of general importance. With such knowledge the stockman would know what parasites were to be guarded against as being already in his neighborhood and what were to be guarded against in shipping in stock from other places. A fairly complete record of distribution would indicate foci of infection and awaken the interest of persons resident at such foci. Such a record is essential in campaigns of eradication, as we know from experience with the hookworm disease, sheep scab, and Texas fever, three of the best known of the diseases due to animal parasites. From a scientific standpoint such records would be valuable as showing whether the conditions necessary for a parasite's life cycle exist only in a restricted area or over practically the entire country.

When these things were known, certain lines of action previously impossible or not definitely indicated would become possible and definitely desirable. Knowing the distribution and economic importance of a parasite, we would know how much we might fairly emphasize the subject and to what localities an educational campaign should be directed. In this way the forces that would otherwise be wasted in a misdirected effort at points where a given parasite did

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not exist would be conserved and expended over infected areas. Parasites that have not yet been distributed over the entire country could then be restricted to the places where they have a foothold, and in time eradicated from these places. From a scientific standpoint a knowledge of the distribution of a parasite would probably throw some light on its habits and its life history, and perhaps indicate a corresponding distribution of intermediate hosts or of other conditions requisite for the life cycle. This in turn would permit of outlining more adequate means of prophylaxis.

LACK OF DATA.

With such rare exceptions as in the case of Texas fever and sheep scab, which are matters of quarantine, hookworm disease of man, which is now a matter of special study and investigation under the Rockefeller fund, and the yellow-fever mosquito, which was investigated by Howard (1905) in connection with the yellow-fever work of the Public Health and Marine-Hospital Service, the study of the distribution of the parasites of man and the domestic animals in the United States has not been undertaken. One reason for this is that the data necessary for a satisfactory study are not yet available. The preliminary work of the amateur and professional collector, the contributor of short notes and records, has not been done. In fact, the amateur collector of parasites in this country is practically an unknown quantity, and the professional workers are few and, unfortunately for this purpose, concentrated largely in one place. Considerable material has been collected in the Government laboratories at Washington, some of it being sent in from outside places and thereby affording some data. The value of these data is often lessened by a possible or evident unreliability on the part of the collector, who is often not even an amateur in the best sense of the word, but merely the casual collector of a strange object which has caught the attention. Many of these outside records tell practically nothing about distribution, as the parasites were collected in the slaughterhouses at big packing centers, and the locality to which the infection should be referred is unknown. In our literature we have very few records made by specialists at universities, and of the limited records of the physicians, veterinarians, and experiment-station workers a large amount is casual, indefinite, or unreliable.

Nevertheless, in spite of the lack of such data as would serve to give a fairly complete statement of the distribution of a parasite, it is still desirable that a preliminary and necessarily incomplete statement be made. In the first place, such a preliminary statement furnishes a considerable incentive for additional records. Most persons would be willing to record the finding of a zoological specimen if they thought the record would serve any purpose, or would send it to

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a specialist if they thought he could use it or would want it. The idea that the specimen is probably of no interest or value usually prevails and the matter ends there. The more common a specimen is to a collector, the less value or importance he will attach to it. Many do not know that records of occurrence are of real value, or appreciate that the fact that a species is common is apt to indicate that it is of economic importance. It is furthermore impossible for most persons to look up the scattered literature to see whether a species is recorded from a given locality, owing to the lack of literature, time, or inclination. When a preliminary statement of the distribution is available, it is easy to determine whether a parasite has been recorded from a given locality, and there is incentive to make such a record if it has not been made, or to fill gaps in the record from literature that has been overlooked. Conversely, such records of distribution serve as a guide in looking for parasites, since they show that a given parasite has been found at a given point and may be expected to occur there again, or that it has not been found and that the finding will be an addition to our knowledge. Incidentally it may be said that in this country many parasites, as well as many findings, would be new.

As an illustration of the utility of such a preliminary survey, we may take the work on the hookworm. With the preliminary records of Stiles (1902 hh, 1903 l, et al.) it was possible for various physicians to add intelligently to the records, thus mapping out the infected areas. Conversely, it led physicians to look for the hookworm in those States from which it was recorded or where the records indicated that it would be found, for such records indicate possibilities and probabilities in addition to showing known facts.

THE PRESENT STUDY.

It is almost impossible at the present time for anyone, even though in close touch with the parasite work of this country, to say out of hand whether a given parasite occurs in a given State, or to give the range of a parasite, or name the parasite fauna of a State, even for parasites of considerable importance. It would be a work of years to get such a statement for all the parasites of recognized economic importance. It is hoped that the present paper will serve as a nucleus for such a work, and that those who come in contact with parasites may be induced to group new records around these. This paper is limited in its scope to nine of our more important and representative parasites. Even within these limits it is admittedly incomplete. The papers from which it is compiled in part are scattered and unrelated for the most part, and it is out of the question to get hold of all the papers that would add to our knowledge of the distribution of these parasites. This incompleteness is itself an additional reason

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for making this preliminary record. It should lead to filling the gaps which are due to the writer's failure to take cognizance of published records, and those which are due to an actual lack of records, much sooner than would be the case if this compilation were not made. It is hoped that in time sufficient data will be available to permit of a biological survey such as is possible with our bird, mammal, or insect fauna. Of course, such a survey would be very definitely limited and modified by the dominating condition of parasitism.

THE MAPS.

It is essential in work of this sort that the distribution be graphically shown by the use of maps. At the same time, maps based on inadequate data must be inaccurate, a fact which must be kept in mind in using these maps. For one thing, it is out of the question in all cases to take cognizance of small uninfected areas which care or accident has kept free from infection although surrounded by infected areas. For the most part it is also impossible to indicate on a map those areas which are uninfected for the reason that the host animal in question does not exist within that area. Finally, a sweeping statement to the effect that a parasite causes severe loss over an entire State must be transferred to the map in symbols indicating that the entire State is infected, whereas there might perhaps be fewer counties infected than in some other State where more careful work and more adequate and exact data have shown only a part of the State to be infected. The nature of our data from any given locality is indicated as exactly as is possible with the use of a limited number of symbols. Where a map record is not referred to in the text the record has usually been made from the official letter files of the bureau.

DISTRIBUTION OF SOME SHEEP AND CATTLE PARASITES.

The parasites which have been selected for study as regards their distribution in the United States include representatives of the various parasitic groups. They are also some of the best known and most important parasites in their groups, as far as this country is concerned. Some of them are apparently spreading, others are being eradicated, while it is impossible to tell about others, owing to the lack of data covering their distribution in the past.

The parasites in question are: *Piroplasma bigeminum*, the protozoan which causes Texas fever in cattle; *Fasciola hepatica* and *F. magna*, the flukes responsible for liver rot in sheep and cattle; *Multiceps multiceps*, the larval tapeworm causing gid in sheep; *Thysanosoma actinioides*, the fringed tapeworm of the bile ducts and intestines of sheep; *Hæmonchus contortus*, the stomach worm of sheep;

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Œsophagostomum columbianum, the nodular worm, a nematode causing nodular disease or "knotty guts" in sheep; *Œstrus ovis*, the sheep gadfly, which passes its larval stage in the nostrils and frontal sinuses of the sheep under the name of "grub in the head;" and *Psoroptes communis ovis*, the mite which causes sheep scab or scabies.

Piroplasma bigeminum.

Smith (1889 b) first recognized that the intracorpuscular blood parasites (fig. 45) which occur in the blood of cattle affected with Texas fever were protozoa. An extensive description of the disease and its parasite was given by Smith and Kilborne (1893) in a work which is now a classic and rated as one of the most important in the field of protozoology. They proposed the name *Pyrosoma bigeminum*, but the generic name *Pyrosoma* was preoccupied, as was the name *Apiosoma* proposed in place of it by Wandolleck. The name proposed by Patton, *Piroplasma*, is commonly accepted, though there is a possibility that the parasite is generically identical with forms included in the genus *Babesia*, and that this should be the generic name. This, however, has not yet been demonstrated. Theiler (1910) notes that Smith and Kilborne distinguished two forms of the parasite in the blood and believes that the small coccuslike forms at the margin of the blood corpuscle are not parts of the life cycle of the piriform parasite, but represent a different parasite, for which he proposes the new generic and specific name *Anaplasma marginale*. According to this view, the Texas fever of this country is the result of a mixed infection. It is as yet too early to pass judgment on Theiler's claims.

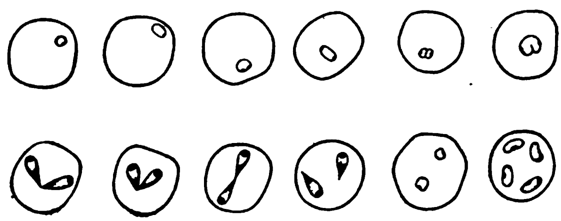

FIG. 45.—Texas-fever parasites (*Piroplasma bigeminum*) in the blood corpuscles of an ox. Enlarged. (After Laveran and Nicolle.)

When *Piroplasma bigeminum* is conveyed to the blood of cattle by the bite of the tick *Margaropus annulatus* (Pl. XXXV, fig. 1) (this tick is also known by the name *Boophilus annulatus*), the parasite multiplies in the blood and attacks the red blood cells. The red blood cells being destroyed, the coloring matter of the blood is excreted by the kidneys and causes the red color of the urine, which gives this disease the name "red water." The disease is accompanied by a high fever, and the animal becomes thin. Mohler (1905) states that death occurs in from 10 per cent of the chronic to 90 per cent of the acute cases. The chronic cases are found among

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southern cattle which are infested with the fever tick from birth or in cases usually appearing in late autumn or early winter; acute cases occur among cattle not naturally immune which are subjected to heavy infestation, usually in summer.

The great losses due to Texas fever, the ease with which the disease can be recognized clinically, and the fact that it depends for its spread upon a specific carrier, the Texas fever tick, and can therefore be prevented from spreading by such a simple routine procedure as dipping and thereby destroying the ticks, early led to this disease becoming a subject of quarantine. As a result it was soon confined to the territory in which it was properly enzootic, and the distribution of the disease can be found at once by reference to the quarantine lines which separate the infected southern part of the United States from the uninfected northern part. (See fig. 46.) As will be seen by the map, there are a few small infected areas just north of the principal infected area and surrounded by uninfected territory. Along the northern edge of the quarantined area the disease is being stamped out as rapidly as possible under the direction of State and Federal authorities, especial attention being paid to the eradication of the tick. As soon as areas south of the line and bordering on it are tick free the line is moved south of these areas and the restrictions on shipment imposed by the quarantine are removed. These restrictions require that shipments from January 31 to November 1 be made only under certain specified conditions.

Previous to the establishment of the quarantine line no State in the Union could be considered free from Texas fever. Practically every shipment of southern cattle left the disease among the cattle of the States through which they were shipped. This was due to the fact that infected ticks dropped off in transit, and larvæ hatching from the eggs laid by the engorged females attached to northern cattle and thereby conveyed to them the *Piroplasma bigeminum*. Salmon (1885), in the first report of the Bureau of Animal Industry, records the establishment of the boundary of the permanently infected region in the United States east of the Mississippi River. The boundary line as thus established extended across Virginia, North Carolina, the northern end of Georgia, and Tennessee. On July 3, 1889, the first Federal quarantine on account of Texas fever was declared in an order issued by the Secretary of Agriculture, the quarantine line extending across Arkansas, the Indian Territory, and Texas. The line was altered somewhat by Secretary Rusk's order of February 24, 1890. On February 5, 1891, the quarantine line, with some alterations, was extended east along the southern boundary of Kentucky and across Virginia to the Atlantic Ocean. The line was finally established across California, and so from coast to coast, by Secretary Morton's order of February 5, 1895.

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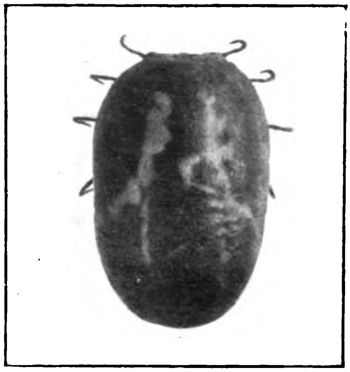

FIG. 1.—FULL-GROWN FEMALE TICK (MARGAROPUS ANNULATUS), ENGORGED AND READY TO DROP TO GROUND AND DEPOSIT EGGS.

(From Farmers' Bulletin 378.)

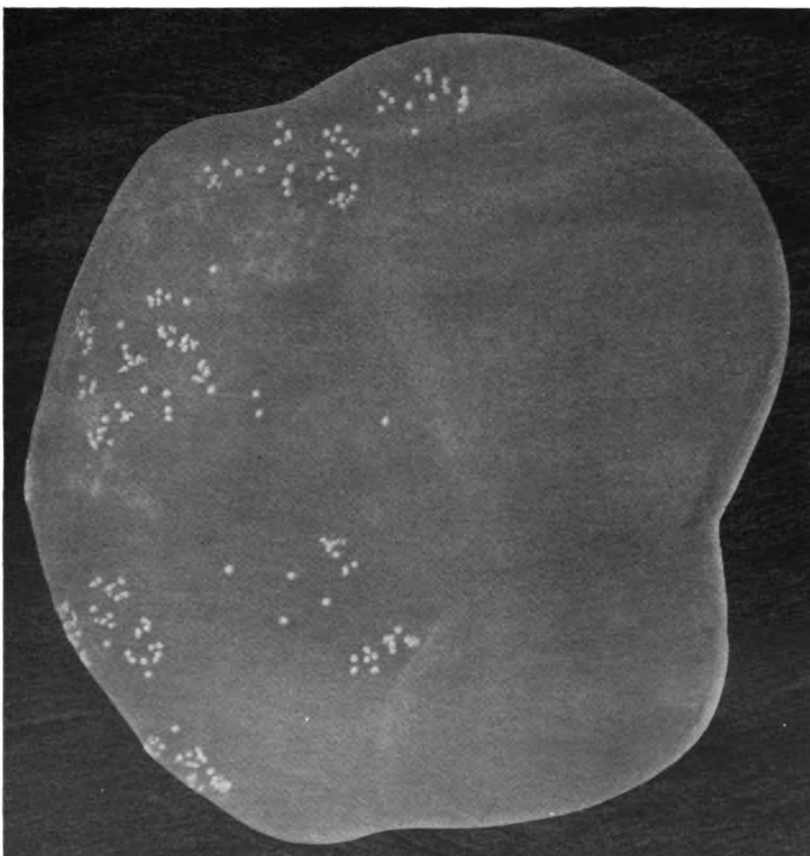

FIG. 2.—THE GID PARASITE (MULTICEPS MULTICEPS) FROM BRAIN OF SHEEP.

(From Bureau of Animal Industry Circular 165.)

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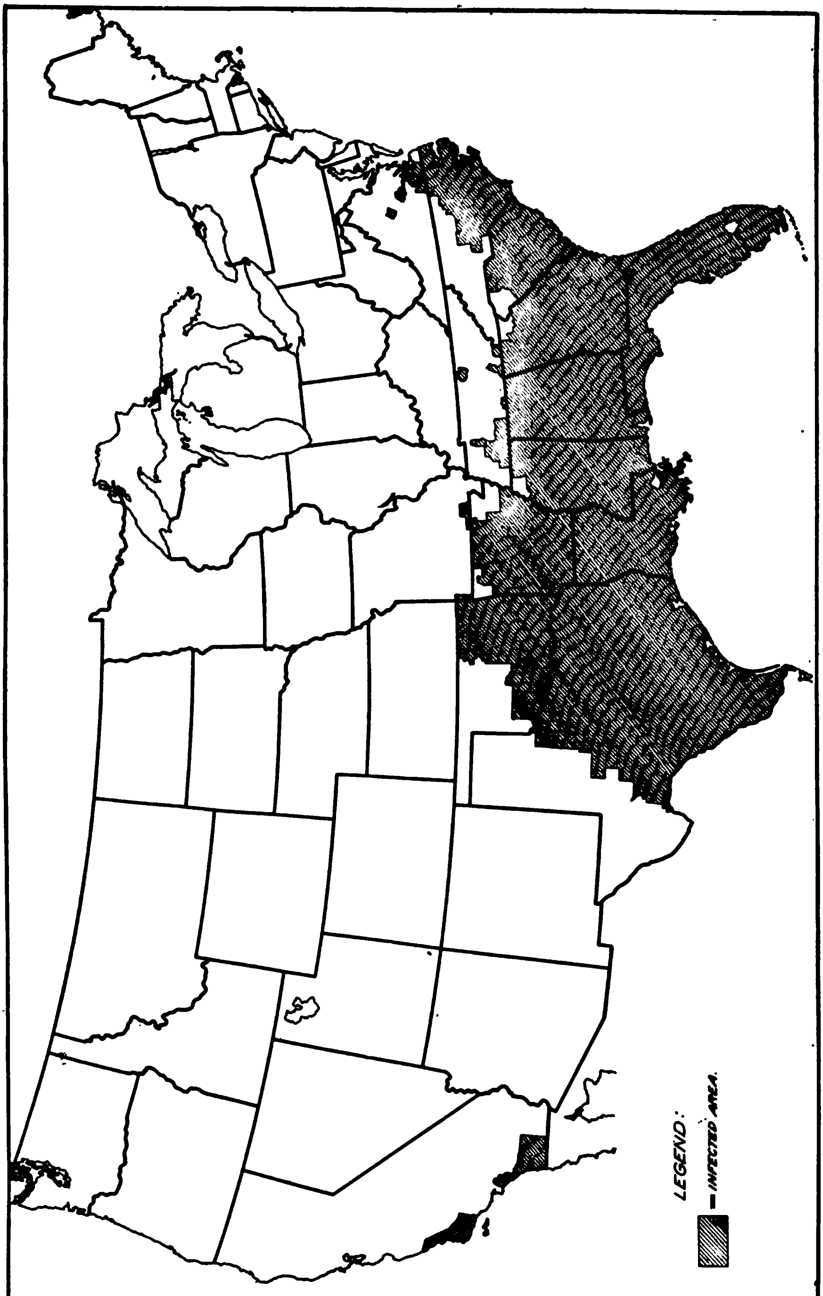

FIG. 46.—Map showing area infected with Texas-fever cattle ticks (*Margaropus* (*Boophilus*) *annulatus*).

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Mohler (1905) says that the estimated loss to the infected district from Texas fever is $40,000,000 per annum, with an additional $23,250,000 loss in lowered assets. These figures are sufficient to show the magnitude and importance of this disease. It limits the southern stockman and farmer in disposing of their stock, in shipping in cattle to improve their herds, and in holding fairs and exhibitions of stock.

Fasciola hepatica.

This is the common liver fluke of sheep. It has been found in sheep in practically all countries where sheep are kept and has been a source of considerable loss for centuries. It is a flat worm (fig. 47, *a*), commonly 1 or 2 inches long, and has a complicated life history. The life cycle can only be completed after passing certain stages in the bodies of certain snails. At the end of the development period within the snail a larval form known as a cercaria is produced. This leaves the body of the snail, attaches to a blade of grass and encysts. When swallowed by a sheep or cow the cyst is digested and the parasite makes its way to the liver. The adult worm produces vast numbers of eggs which are passed with the feces of the host. In such of these as fall or are washed into bodies of water there develops an embryonic form which escapes from the egg and infests suitable snails.

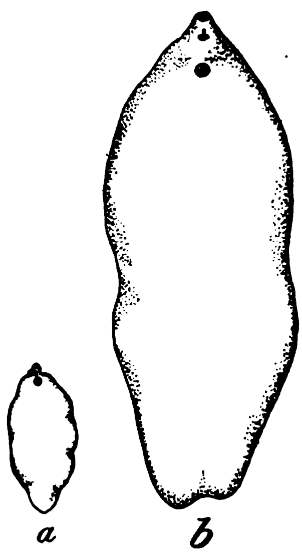

FIG. 47.—*a*, The common liver fluke (*Fasciola hepatica*). *b*, The large American fluke (*Fasciola magna*). Natural size. (After Bureau of Animal Industry Bulletin 19.)

The infected sheep may at first get fatter, then they become thin, feeble, and anemic, many of the sheep dying. The bile ducts are obstructed, their walls become thickened and hardened, and the liver atrophies. Bad effects are less noticeable in cattle than in sheep. In the spring and early summer the flukes leave the liver, only the remaining scars and other lesions indicating where they were located.

In this country the liver fluke has become fairly well established along parts of the Pacific, the Gulf, and the eastern Atlantic coasts (fig. 48). From the coast it works inland along the river valleys. This distribution is precisely what would be expected in the case of a parasite requiring a snail for an intermediate host. It does not seem to have become established at any remote inland points, although

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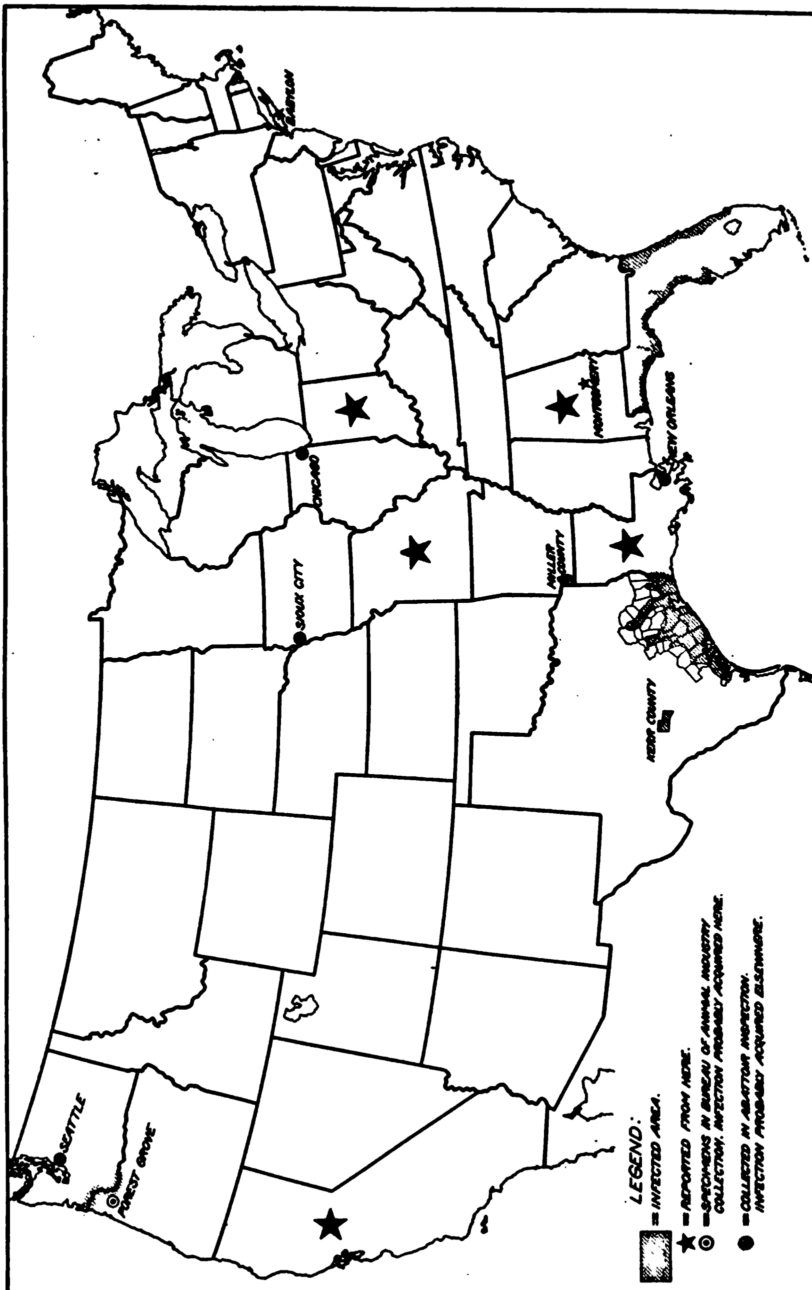

FIG. 48.—Map showing infection with the common liver fluke (*Fasciola hepatica*).

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it is occasionally found in abattoir inspection at Sioux City and Chicago. In such cases the host animal has been shipped in, presumably, from the regions which are here shown to be infected.

The parasite is established on the west coast. Gordon (1883), in the Tenth United States Census Reports for 1880, quotes a letter from a sheepman in California, who says: "Our diseases are fluke, scab, water on the brain, and foot rot; the first is the most fatal." Curtice (1890 c) states that flukes have been seen in California by Prof. E. C. Stearnes, of the Smithsonian Institution. Stiles (1902 pp) notes that 5 per cent of the sheep along the Columbia River bottom were infected with *F. hepatica*, while 75 per cent of the sheep along the western slope of the Cascades in Oregon were infected. The lesser infection in the first case is believed to be due to the carp in the Willamette and Columbia Rivers eating the cystic stage of the fluke on the grass and presumably eating the snail also. The parasite collection of this laboratory has specimens of *F. hepatica* collected from the cow at Forest Grove, Oreg., in 1892, and in 1905 Dr. Elda R. Walker, of the University of Nebraska, told the writer of having known of cases of fluke in sheep at Forest Grove, the flukes being believed by the owner of the sheep to be leeches which had been swallowed in drinking. This is a rather widespread belief. Stiles (1902 pp) notes the occurrence of this parasite at Ridgefield, Wash., and the parasite collection here has specimens collected from the sheep at Lake Cushman in 1904, and some collected from the goat, probably in abattoir inspection, at Seattle in 1905.

The parasite has been established in the Gulf States for over 30 years. Gordon (1883), in discussing the diseases of sheep in Texas, writes: "A flockmaster of San Saba County reports in 1877 a loss of 1,198 sheep out of 1,515 by liver rot." Detmers (1883) says: "This parasite occurs frequently only on the low and level lands near the Gulf. * * * In comparatively rare instances the flukeworm * * * also occurs in other parts of Texas—for instance * * * in Kerr County." This was written before *Fasciola magna* had been recognized as an American parasite, and Detmers was undoubtedly dealing with mixed infections involving both species of flukes, as Francis (1891 c) records both from Texas and gives a map showing the area over which the mixed infection occurs. Of *F. hepatica*, Francis states: "This well-known parasite occurs in the livers of cattle, sheep, and goats of Texas in sufficient numbers to cause great damage. The portion of the State permanently infected consists of the coast counties and river bottoms." Stiles (1901 t) notes the finding of *F. hepatica* in two steers in Harris County. Francis (1891 c), in his map showing the distribution of *F. hepatica* and *magna*, figures a part of the coast region of Louisiana as infected territory.

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Wheeler (1894) says of *F. hepatica:*

> This platyhelminth is one of the greatest enemies to the successful rearing of sheep in this whole southern country. Our cattle are likewise the hosts of these worms. * * * I have not been able to observe any difference in the general health of Texas and native cattle and in extent to which these worms prevail in their livers. * * * During the year 1891 I condemned about 2,500 fluky beef and cow livers. Valued at 40 cents a piece, this would amount to $1,900 in livers alone. * * * I did not discover over 50 calf livers fluky during the same period.

This was at the New Orleans abattoir. Later, Wheeler (1896) gives a record of the inspection work at this abattoir for two months, from which it appears that during that period 556 livers and 20 lungs of cattle, sheep, and goats were condemned as fluky.

Cary (1897) writes:

> In Alabama and in most of the Southern States it is observed most frequently in the liver ducts of cattle. This is due to the fact that few sheep are bred in the South. The writer has observed these flukes in the pig in one case at the Montgomery slaughterhouse.

Bitting (1895) records this parasite from Florida along the coast region. He says that nearly all cattle in the infected area have fluke and that there is considerable loss, especially among young animals. There are no sheep in the infected area. He gives a map showing the location of this area. There do not appear to be any records of the parasite from Mississippi, but an inspection of the map indicates that the infection which occurs in Texas and Louisiana to the west, and in Alabama and Florida to the east, under practically the same geographic and climatic conditions, is probably present in Mississippi also. Ward (1895) says that *F. hepatica* is exceedingly common in Arkansas. I am unable to find any authority for this statement other than the fact that Francis (1891 c) indicates the southwest corner of Arkansas as part of the territory with a mixed infection. Dinwiddie (1892 b) states that he has never seen a fluke in the sheep in Arkansas, and the fluke which he reports from cattle is *F. magna.*

Dr. Luckey writes me under date of March 2, 1911:

> Upon one occasion several years ago I found a number of cattle in the lowlands of southeast Missouri heavily infested with *Fasciola hepatica.* This is not generally prevalent over the State.

An examination of the maps, together with the fact that the fluke was in cattle, indicates that closer examination would probably have shown this to be *F. magna.*

Along the eastern Atlantic coast we have the infection already noted from Florida by Bitting (1895). Aside from this, there is only Stewart's (1882) record of liver fluke in Southdown sheep at Babylon, Long Island, and in Cotswold, Leicester, and native sheep, presumably at the same place.

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As to the interior of the country, it has already been noted that the parasite has been found in abattoir inspection at Sioux City and Chicago, the infection undoubtedly originating elsewhere. That this is true of Sioux City seems the more likely from the report of Niles (1897), who says:

After looking over the literature on the subject, noting the results of several years' personal observations, and gathering as much information as possible from other observers, it can be said that the liver fluke * * * has not been recognized in Iowa.

Of Indiana, Craig and Bitting say:

The liver fluke is of very rare occurrence in this State. As far as known to the writer only six flocks have been affected in the past ten years and in these the affection was brought onto them from the southwest. There is no fear of permanent infection of our pasture.

Luckey (1908) implies that this parasite is present in Missouri, but does not definitely say that it is.

It is evident from the foregoing that this parasite is of importance only on the Pacific coast and in the Gulf States. So far it does not seem to have established itself in the interior of the country, although it seems likely that there are places where favorable conditions for its establishment could be found. The data already given show that it is capable of doing considerable damage in those places where it has already got a foothold.

Fasciola magna.

This fluke (fig. 47, *b*), known as the large American fluke, may attain a length of 4 inches. It is commonly recorded from the cow in this country, but it has been recorded from a number of species of the Bovidæ. It has been found in the sheep in Italy in 1874–75 by Bassi, according to Railliet (1895), and the parasite collection of this laboratory has some specimens collected in January, 1906, from sheep at Hillsdale, Mich., which Dr. Ransom determined as *F. magna*. The sheep appear to have been shipped in from the State of Washington. Quite a number of sheep died, apparently from this parasite, and the Michigan sheepmen, who were feeding western lambs, were very much worried. This parasite was sent in to this laboratory by Dr. Ketchum, of the St. Paul meat-inspection station, in the summer of the same year, with the report that it had been collected from the sheep.

The life history and the intermediate hosts of this parasite are unknown. From the close relation of this fluke and the common liver fluke of sheep, and from the fact that the infected range of the two forms is very nearly the same, cattle frequently being infected with both flukes at the same time, it is probable that the life history of the two flukes will be found very similar and the intermediate hosts perhaps the same.

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The occurrence of the large American fluke on the Pacific coast is a matter of speculation at present. As has just been noted, the sheep at Hillsdale, Mich., which were infected with this parasite appear to have been infected in Washington, but the records were not positive on this point. Curtice (1891 b) diagnosed a case of fluke disease in dairy cattle in Marin County, Cal. The diagnosis is made from a letter that clearly describes the fluke. Curtice states that while investigating animal parasites on the Pacific coast and in Texas, he found flukes in various localities. According to Stiles (1894), Dr. Curtice has stated that the flukes in the case noted were *F. magna*. The present writer is in doubt on this point. The flukes are stated to have been an inch long. They were in a State where fluke occurs in sheep, and the fluke which is known from the Pacific coast is *F. hepatica*.

The area with the greatest amount of infection is found in Arkansas and in the coast region and river valleys of Texas. (See fig. 49.) Francis (1891 c) states that he saw the parasite in Texas three years previous to 1891. Curtice (1887) recorded what he termed *Distoma hepaticum* (*Fasciola hepatica*) from the liver and lungs of Kansas cattle. Stiles (1894) says that Curtice has since told him that the parasites were really *F. magna*. It is quite as likely that Murray (1882) was dealing with *F. magna*, or with this and *F. hepatica*, in his report of *Distoma hepaticum* found in the lungs of Texas cattle at the Detroit slaughterhouses, as that he was dealing with *F. hepatica* alone.

Francis (1891 c), in his discussion of the large fluke, described it as a new species under the name of *Distomum texanicum*. Hassall (1891 a and 1891 c), in two articles which antedate that of Francis, had already named this *Fasciola carnosa*, and then changed this to *F. americana*, because the specific name *carnosa* was already preoccupied. This fluke had previously been named *Distomum magnum* by Bassi (1875 b), which name had been corrected to *Fasciola magna* by Stiles (1894).

Hassall (1891 a) had figured his specimen of *Fasciola carnosa*, and the figure is labeled "from liver of a Colorado steer." Stiles (1894) lists as part of his material "several specimens collected by Dr. Curtice at Colorado Springs (Hassall's type-specimens of *Fasciola carnosa* seu *americana*)." There are a number of reasons for thinking that this parasite has no foothold in Colorado, and it seems quite probable that the infected animal had come to Colorado from Texas or Indian Territory, the parasite occurring in cattle in Indian Territory, according to Dinwiddie (1892 b).

It seems uncertain whether the fluke has established itself in Kansas. We have the record of Curtice (1887), who says that "3 out of a herd of 12 from Kansas were found to be infected with flukes," which

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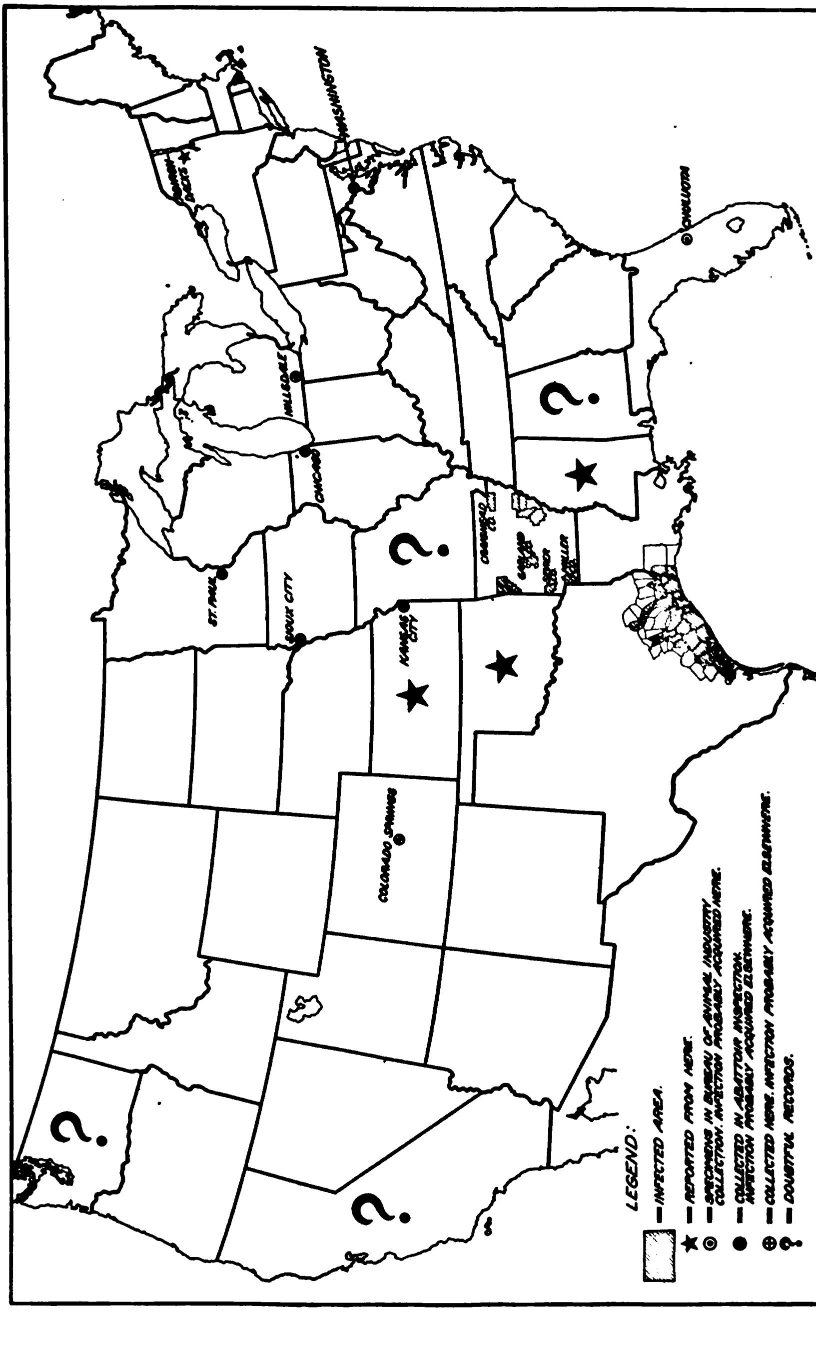

FIG. 49.—Map showing infection with the large American fluke (*Fasciola magna*).

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flukes Dr. Curtice later said were *F. magna*, according to Stiles (1894). The parasite collection here has specimens collected from *Bos taurus* in Kansas in 1892. It is nevertheless possible that the infected animals became infected in Texas or Indian Territory (now part of Oklahoma).

Arkansas rivals Texas in the extent of infection with this fluke. Dinwiddie (1890) reported that 90 per cent of all the cattle on certain ranges in St. Francis and Lee Counties were infected. Later, Dinwiddie (1892 a) reported that the fluke infection was found in 11 counties in regions corresponding more or less closely with overflow districts along the rivers.

The fluke occurs in Louisiana, according to the map published by Francis (1891 c). A fluke 3 inches long and 1 inch wide was collected by G. V. Young from the liver of a deer at Waverley, Miss., and determined by Osborn (1890 a) as a species of *Distoma* other than the common liver fluke of sheep. This was undoubtedly *F. magna*. Cary (1897) states that in Alabama *F. hepatica* occurs mostly in cattle. He says nothing of *F. magna*, but it is likely that part of the flukes found in Alabama cattle are this species. Similarly, Bitting (1895) records only *F. hepatica* from cattle in Florida, but some specimens collected by Mr. Mills from the deer in Florida and sent in to this laboratory are *F. magna*, and it is quite likely that this is as common in Florida as is *F. hepatica*, and perhaps more common. There is nothing to indicate that Bitting's determination is more than a casual determination, and it would not be difficult to confuse the two flukes. It is furthermore true that *F. magna* is in general a cattle fluke, just as *F. hepatica* is in general a sheep fluke. It has already been noted that the flukes found by Dr. Luckey in southeastern Missouri, and hence near the known infected area in Arkansas, were probably *F. magna* rather than *F. hepatica.*

Outside of the Gulf region the records are inconclusive. Stiles and Hassall (1894 d) record a specimen from the Virginia deer in the Adirondack region of New York. Stiles (1894 c) states that it occurs in Iowa or has been found there. He gives a reference to Osborn (1890 a), but it appears from an examination of this record that, although Osborn was writing from Iowa, the flukes were collected in Mississippi, as noted earlier in this article. The only records I find from Iowa are specimens collected in abattoir inspection in 1907. Niles's (1897) statement of his failure to find the liver fluke in Iowa may be taken to cover *F. magna* as well as *F. hepatica.*

F. magna has been frequently collected in abattoir inspection. It was collected in the District of Columbia by Dr. Hassall in 1893 from a steer said to be from Texas. The parasite collection of this laboratory has a number of specimens collected in the Chicago abattoirs, some others from Sioux City, and some from St. Paul.

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This fluke has been found in a number of American Bovidæ, and it is possible that the parasite is a native of this country. Stiles (1895 l) has suggested this, and also the alternative possibility that this fluke is a species which has developed from *Fasciola hepatica* since the introduction of the latter into this country. The earliest record of this parasite which I have found is that of Stewart (1882), who prints a drawing "from nature" of a fluke collected from the liver of a deer in 1874–75. The drawing is said to be reduced one-half and is 3.85 centimeters long. There is no doubt that this fluke, 7.7 centimeters long, is *F. magna.*

Ward (1895) says of this parasite: "In importance it stands hardly second to *F. hepatica.*"

Stiles (1898 a) says:

> The large American fluke appears to be more frequent in this country than the so-called common liver fluke, although this opinion is the result of general impression from abattoir inspection rather than a view based upon actual statistics. * * * Fortunately this species (so far as known) does not occur in sheep, and on that account it must be looked upon as of less importance than the common fluke.

As the writer has already noted, this species had been found in the sheep in Europe and has since been found in the sheep in this country. It seems to be rather rare in the sheep, which would perhaps be an argument against the hypothesis suggested by Stiles (1895 l) that this was a rather recently evolved species originating from *F. hepatica* since the importation of that form into the United States with domestic stock. It does not seem likely that a recently evolved species would so nearly forsake the normal host to which centuries of parasitism had accustomed it.

Generally speaking, this fluke does not seem to make the impression on the health of cattle that *F. hepatica* does on the health of sheep. Consequently the loss is less frequently noted in terms of dead cattle and oftener in the lesser losses resulting from loss of weight, condemnation of infected livers, and the like.

Multiceps multiceps.

This parasite, the popular name of which is the gid bladderworm, is generally known as *Cœnurus cerebralis*, but the writer (Hall, 1910 a) has shown that the correct name is *Multiceps multiceps.* It occurs in the central nervous system of the sheep and cow and also in that of a number of other animals. It is found in the brain in the great majority of cases, and looks like a fish bladder filled with water (Pl. XXXV, fig. 2). This bladder varies in size, but at the time of the host animal's death it commonly ranges from the size of a nut to that of a hen's egg. It is sometimes larger, and the one shown

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in Plate XXXV contained 80 cubic centimeters of fluid. On the walls of the bladder are a number of scolices or tapeworm heads, sometimes hundreds. When the bladder is eaten by a dog—and it is essential that a dog, coyote (see Hall, 1911), or perhaps some other suitable carnivore eat the bladder if the parasite is to undergo further development—the bladder walls are digested in the dog's stomach and the heads pass to the intestine, where they become the heads of a corresponding number of tapeworms. Numerous tapeworm segments form back of these heads, ultimately resulting in the development of tapeworms 2 or 3 feet long (fig. 50). Thousands of very small eggs are produced by the worms and pass out in the feces of the dog, sometimes inclosed in the terminal segments as these break off, and sometimes freed from the segments when these have ruptured and scattered the eggs throughout the feces. These eggs are released from the feces by rains and in this way are splashed onto plants which are eaten by the sheep, or washed into pools of water from which the sheep drink. When the eggs are taken into the stomach of the sheep the shell digests, thereby releasing a small embryo armed with six hooks. The embryo bores its way through the walls of the digestive tract and into the blood vessels. It is then swept around in the blood current till it lodges. If it lodges outside of the central nervous system, the parasite starts to grow, but aborts in a short time. In the central nervous system the parasite usually wanders around through the brain tissue for a time and then grows to form the bladderworm already described.

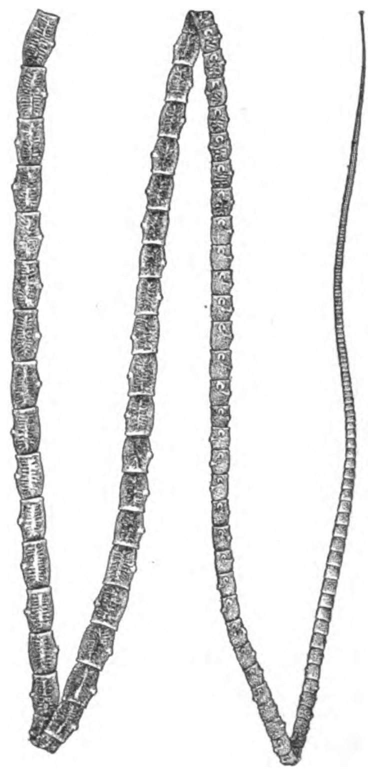

FIG. 50.—The adult gid tapeworm (*Multiceps multiceps*) from the intestine of the dog. Natural size. (From Bureau of Animal Industry Circular 165.)

The wanderings of the parasite in the brain cause a certain degree of fever and restlessness, which is usually overlooked. If the number of parasites is very large the sheep may die at this time. Postmortem will then show numerous curving channels on the brain, due to the wanderings of the embryos. Usually the symptoms abate and there is no further indication of the presence of the parasite until it has grown to the point where the heads form on the bladder and set

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up the symptoms characteristic of the last stages of gid by projecting out of the bladder and into the brain. As a result of the irritation due to these heads, which are armed with hooks, and of the pressure due to the growth of this large parasite within the skull, the sheep displays symptoms indicative of the derangement of the central nervous system, such as walking in a circle or constantly repeating some other meaningless automatic action, constant carriage of the head to one side, ceasing to eat, blindness, and the like. Unless the parasite is removed or destroyed by surgical intervention, the infected sheep invariably dies.

The writer (Hall, 1910 a) has already recorded the distribution of this parasite for the world. In the United States the permanently infected area is in northern Montana and is about 400 miles long and in places 200 miles wide (fig. 51). There was a small infected area in New York in 1909 and in Iowa in 1910. The parasite has been reported, apparently correctly, from Ohio, Illinois, Michigan, Missouri, Kansas, Indian Territory, and Nevada, and there are doubtful records from Utah, Colorado, and Tennessee. There is a possibility that small infected areas occur in these States, but so far it has been impossible to locate any. It seems likely that most of the cases in these States were imported from abroad or from the infected area in Montana. A hasty investigation, by the writer, of conditions in Idaho, Nevada, Utah, Colorado, and Wyoming in the spring of 1910 failed to disclose any evidence that the disease had a foothold in those States.

Evidence obtained by the writer in an investigation in Montana indicates that the losses from this disease amount to at least $10,000 in some years. It is difficult to determine the entire loss, as the disease is confused by the sheep men with other diseases, such as loco and grub in the head, notwithstanding the fact that the disease has existed in this State for over 20 years. The gid disease is of especial economic importance in that it is always fatal to the animal attacked, unless the animal is saved by a successful operation. It has been a scourge to the flocks of Europe for centuries, and it is highly desirable that it be kept within the area now known to be infected and eradicated from that area as soon as possible in order to remove the menace of its presence from the United States.

Thysanosoma actinioides.

This tapeworm is commonly known as the fringed tapeworm, for the reason that the posterior border of each segment has a fringe of projections (fig. 52). These can be easily observed when the parasite is put in water, as the fringe floats out from the segment. The worm is sometimes a foot (30 centimeters) long. Very young stages consisting of little more than the head have been found by Curtice

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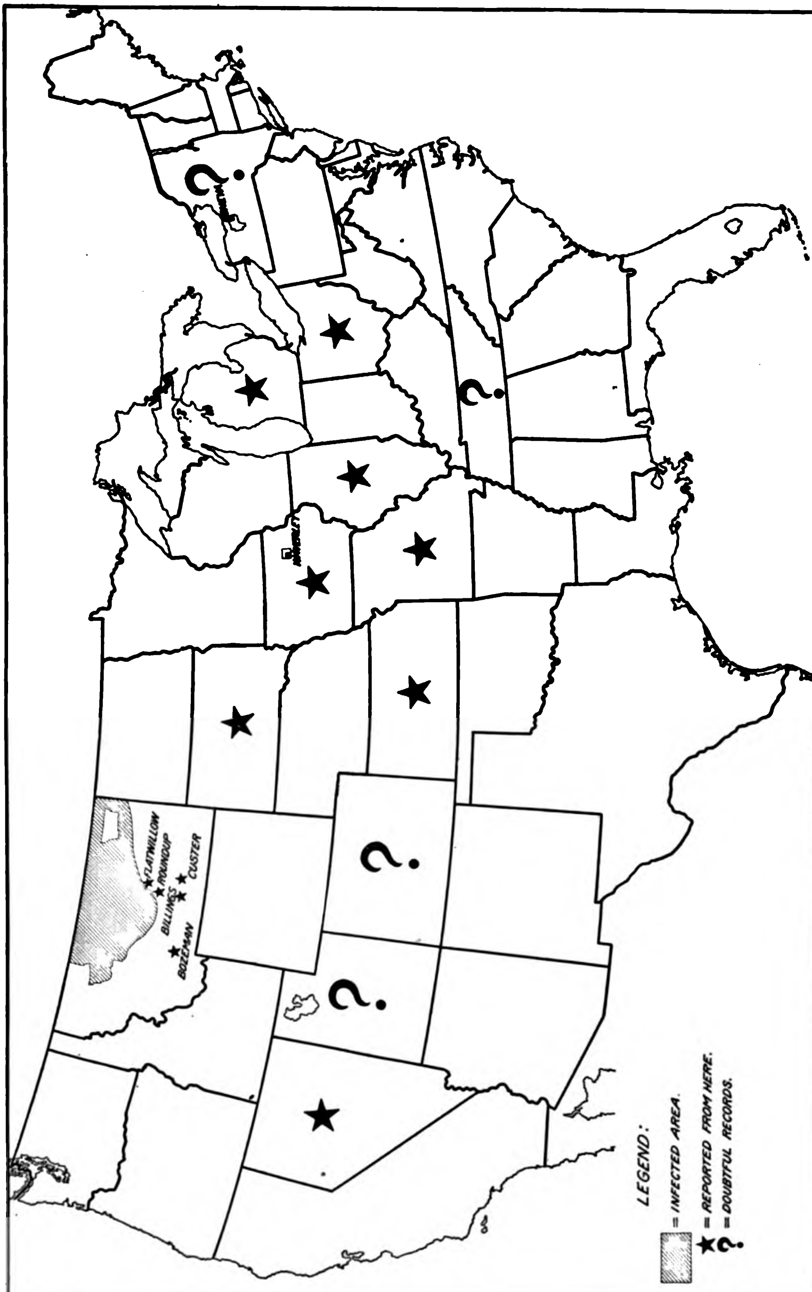

FIG. 51.—Map showing infection with the gid parasite (*Multiceps multiceps*).

(1889 and 1890 c). From these to the fully developed tapeworm is merely a matter of growth. But the life history from the time the posterior segments containing the eggs pass out in the feces of the sheep is unknown. There is reason for thinking that the egg must be subsequently ingested by some intermediate host in which it develops to a larva capable of infecting the sheep with the tapeworm, but nothing is known about this.

Contrary to the usual custom with adult tapeworms, this worm inhabits not only the small intestine of the sheep but also the bile ducts and the gall bladder, and occasionally the pancreatic ducts. This obstruction of the bile ducts deranges the liver and interferes with digestion. Digestion is further interfered with by the obstruction and irritation due to the parasites in the intestine. This interference with digestion results in the host animal becoming thin and enfeebled, and sets up a train of nervous symptoms which naturally follow malnutrition and indigestion. These nervous symptoms are aggravated by the visceral irritation due to the attachment and movement of the tapeworms. The disease needs more study, but there seems to be little room for doubting the conclusions of Curtice (1890 *c*), who says:

> Sheep do not die from the tapeworm disease alone * * * The majority may die during cold storms, either from freezing or from suffocation while piling upon each other for warmth. They may starve to death either from inability or lack of desire to eat. They may die from other diseases. The tapeworm disease appears to render them more liable to other affections and less able to withstand the inclement season. It is therefore indirectly chargeable with the loss. Even if the infected sheep do not die, the parasite is still a cause of pecuniary loss. The impoverished condition traceable to it is a small average loss for each animal, but for flocks of over 5,000 sheep the aggregate is thousands of dollars for each ranchman.

Fig. 52.—The fringed tapeworm (*Thysanosoma actinioides*). Natural size. (From Bureau of Animal Industry Bulletin 4.)

As the map (fig. 53) shows, this worm is essentially a parasite of western sheep. Although the data are not evident for demonstrating the fact, it is probable that the infected area includes practically all the States west of the Mississippi River, and that practically all the States east of the Mississippi are uninfected. The reason for this distribution is not evident at the present time, but it will probably be clear when the life history of the worm becomes known. There is a possiblity that an intermediate host necessary in the life history of the worm has a corresponding distribution. The States which the available records

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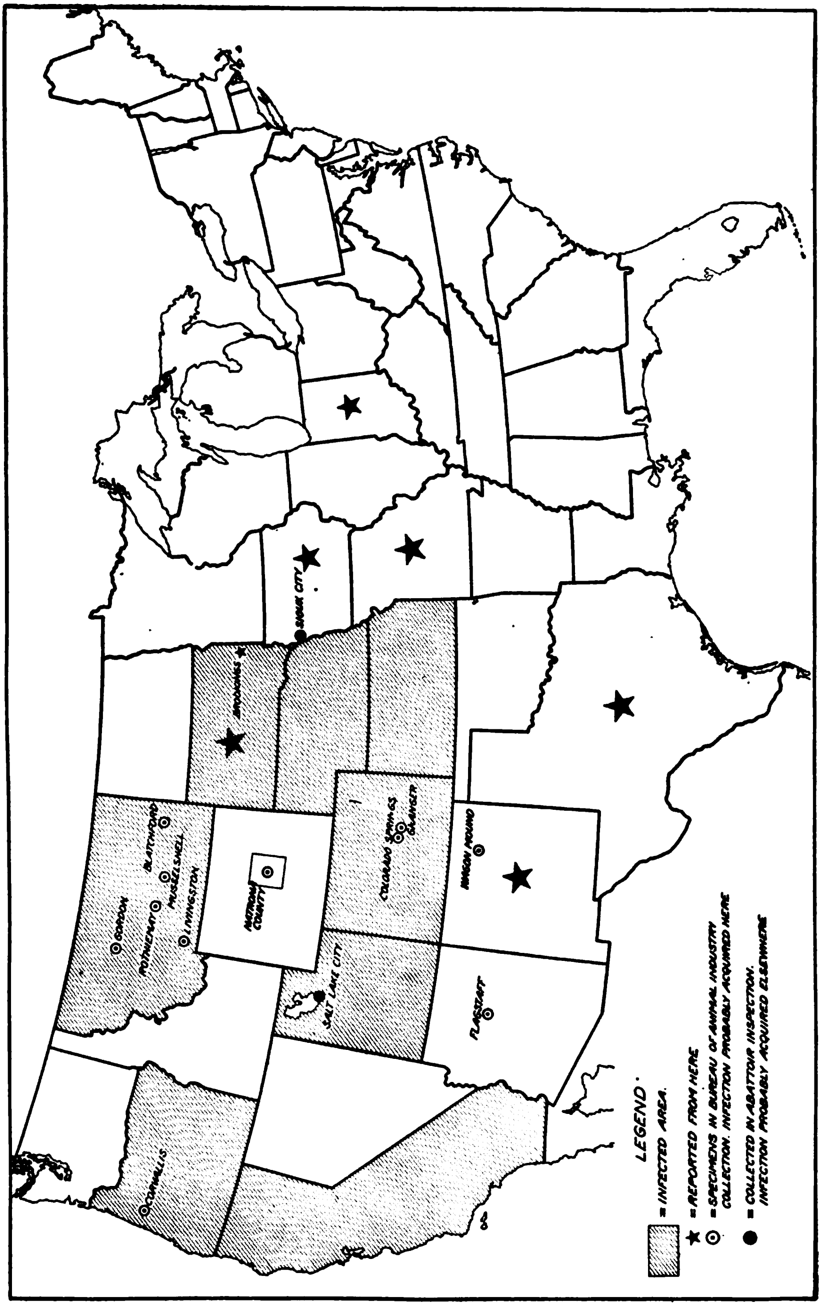

FIG. 53.—Map showing infection with the fringed tapeworm (*Thysanosoma actinioides*).

warrant us in labeling as infected are Oregon, California, Montana, Utah, Colorado, South Dakota, Nebraska, and Kansas. In the same part of the country the parasite has been recorded from Arizona, Wyoming, New Mexico, Texas, Iowa, and Missouri, and it is probable that these States and the Western States from which we have no records (Washington, Idaho, Nevada, and North Dakota) are all infected to some extent.

In this connection it should be borne in mind that a lack of records is not evidence. Had anyone ever made an investigation and found no evidence of this parasite in the States from which we have no records, it would be evidence, even though negative in character, and we would be warranted in drawing certain restricted conclusions from such evidence. But where a State is more or less surrounded by infected territory and there is no evidence that the infection has been looked for in that State, that alone is sufficient to warrant a suspicion, all other things being equal, that the infection exists in that State.

East of the Mississippi the parasite has been recorded from Indiana. There is no evidence back of the record to show whether the parasite has a foothold in this State, although Craig and Bitting (1903) claim, as noted below, that Indiana sheep have acquired the disease.

This parasite is a native of North and South America. It was first collected in Brazil in 1824. Curtice (1890 c) says that an identification of *Tænia plicata* from Missouri sheep in 1875, in a reference which I am unable to verify, leads him to suspect the presence of *Thysanosoma actinioides* in Missouri sheep. The next record from this country undoubtedly refers to the fringed tapeworm of sheep. The reference is to the report of the veterinary department of the State Agricultural College of Colorado for 1884, and is cited by Curtice in the article just noted. I am unable to verify the reference, but the quotations given by Curtice show that what Dr. Faville calls *Tænia expansa*, in the report referred to, is undoubtedly *Thysanosoma actinioides*. Four years later McEachran (1888), in recording tapeworms from the liver of Colorado sheep, has adopted the name used by Dr. Faville.

Of this parasite Curtice (1890 c) says: "The fringed tapeworm is at present the most common parasite of the sheep of our western plains, and causes by far the greatest loss of any intestinal parasite in this country." In an article apparently by Fischer (1899), from the Kansas Agricultural Experiment Station, it is stated that "this is one of the common intestinal worms affecting western sheep, and causes by far the greatest loss of any parasite affecting this animal in this and adjoining States."

Craig and Bitting (1903), writing from Indiana, state:

The parasite is not of much consequence in this State, except as it is brought in with feeding stock. Whole carloads of sheep brought from St. Louis and

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Chicago have suffered from the affection, and as high as 60 per cent have died. In some few cases the disease has been communicated to the home-grown sheep; but, as a rule, recognition of trouble has been so early, or the flock kept intact until reshipped, so that little spreading has occurred.

In this connection it is interesting to note the statement of Niles (1897), who says: "As far as our observation goes, it is not a common parasite in native Iowa sheep, but the importation of western sheep is likely to introduce it to a greater or less extent."

Of Missouri, Luckey (1908) says: "It is apparently not very common in this State, as only a few reports have been received concerning it." Dr. M. E. Knowles, the State veterinarian of Montana, tells the writer that he thinks the parasite does $100,000 worth of damage a year in Montana. Moore (1903), writing from South Dakota, says: "In our own State it is quite generally distributed. * * * The largest infestation found was 75 distinct worms in one animal. The greatest mortality recorded from one flock was 25 per cent."

Curtice (1889 and 1890 c), whose work on this parasite, done in 1886 and 1887, is still the best summary of our knowledge, says that post-mortem examination of Colorado sheep indicates that 80 to 95 per cent of the sheep in the flocks are infected. He found as many as 100 tapeworms in one sheep. He says that this tapeworm—

is at present the most common parasite of the sheep of our western plains, and causes by far the greatest loss of any intestinal parasite in this country. * * *. The influence on the life and health of its host is not inconsiderable. The ultimate loss is seen when lambs which should be strong and fat are not, and die during the colder weather while the fatter ones survive. This loss * * * can not perhaps be accurately estimated, but is nevertheless present, for thin, hide-bound, dwarfed sheep are not valuable for mutton, nor do they produce as much wool as they otherwise would.

He notes that the sheep are undersized, hidebound, have a rheumatic gait, have difficulty in cropping short grass, act foolish, do not seem to see well, and stay at the rear of the flock. He says:

I think it alone is responsible for more losses than any other sheep diseases on the prairies excepting scab. The direct death rate traceable to it is large when compared to the entire death rate, and the indirect loss traceable to it is, though more insidious in its character, still larger, for it is ever present and ever active.

The disease due to the fringed tapeworm is so largely complicated by other diseases, such as loco disease, that it is difficult to say at this time just what the symptoms of the disease and the loss due to it are. It is certain that it is the cause of considerable loss, and that this loss will not be greatly lessened, in all probability, till we know more about the life history of the worm.

Hæmonchus contortus.

This parasite, often written of under the old name of *Strongylus contortus*, is known as the stomach worm, not because it is the only

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worm parasitic in the stomach of sheep and cattle, but because it is the most important and the most widely distributed. It occurs in the fourth stomach, the place where the hay and other coarse vegetable food of the host animal has finally become converted into chyme, and where the worm can do the most damage in irritation to the mucous membrane and in absorbing food that should be utilized by the host animal.

The male *Hæmonchus contortus* (fig. 54) attains a length of three-fourths of an inch (20 millimeters), and has at the posterior end a clasping organ, known as a bursa, which has a very characteristic bilobed structure. The female (fig. 54) may attain a length of 1¼ inches (30 millimeters), and is characterized by a spiral striping due to the coiling of the two uterine branches around the intestine. The worms are red.

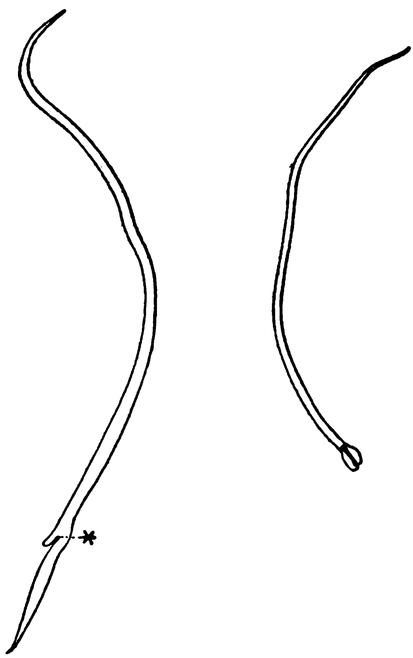

FIG. 54.—The stomach worm (*Hæmonchus contortus*). Enlarged. * Vulva. (From Bureau of Animal Industry Bulletin 127.)

The stomach worm has a simple life history, which was first worked out in detail by Ransom (1906 i). The female produces large numbers of eggs, which are passed in the feces of the host animal. These eggs hatch in two days if the temperature and moisture conditions are favorable, and small embryos, in what is known as the rhabditiform stage, escape. These begin feeding and growing, the skin being molted in the process at least once. The embryo is then in the sheathed stage, its former cuticle completely encasing it. Embryos attain this stage in about 10 to 14 days. The embryo is now sealed up and no longer feeds. Previous to this time the eggs and embryos are easily killed by drying and exposure to low temperatures. After becoming ensheathed, the embryos are very resistant to these conditions. During wet weather and while the dew is on the grass the embryos crawl up the blades of grass, and sheep or cattle eating the grass take the embryos into the stomach where they develop into the adult worms.

The presence of these worms in the stomach results in the irritation of the mucous membranes, causing disturbances of digestion and resulting malnutrition. Moreover, the worm is a bloodsucker by

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virtue of the hook structure in the mouth. This bloodsucking habit results in anemia in the host animal. From these things the sheep become feeble and thin. Some of them die from heavy infections. Others are so enfeebled that when they have to undergo some unusual and adverse experience they are unable to stand the extra strain and perish.

So far the records indicate that the area infected with this parasite to the point where it constitutes an actual menace to the flocks is confined to the Eastern and Middle Western States. (See fig. 55.) The life history of the worm is so simple and its development is so direct that it is probable that the parasite is distributed all over the United States wherever there is moisture enough to permit of the hatching of the egg and the development of the embryo. It is likely that the dryness of the western plains is the factor which has limited the infection with this worm to the point where it has been utterly subordinate to the infection with the fringed tapeworm. A parasite which returns to its primary host in its drinking water has a very fair chance of getting into the water where the host drinks from a puddle on the plains. But one like the stomach worm, which is adapted to crawling up on blades of grass in the dew, is much less certain to infect its host on the western plains than in the Mississippi Valley or along the Allegheny Mountains or Atlantic coast region.

The fact that the writer finds no records to indicate that certain New England or Southern States are infected is perhaps due to the comparative unimportance of the sheep and cattle industries in some of these States, and to lack of investigation in others.

This laboratory has specimens collected at Granger, Colo., as early as 1886, by Dr. Curtice. The fact that this parasite had established itself on the dry Colorado prairies at that early date shows how quickly and easily it gets a foothold. The writer has collected it in 1911 in Elbert and El Paso Counties, Colorado. The infection was usually light, the heaviest infection being 537 worms in a 3-months-old lamb. The 1911 records from Colorado are not shown on the map.

Dalrymple (1903) says of the lamb diseases in Louisiana: "We are of the opinion that * * * stomach-worm disease is responsible for a large percentage of the mortality." Luckey (1908) says that it is reported from all parts of Missouri, the percentage of loss, especially among lambs, often being very high. Stiles (1902 a) found this parasite in about one-third of the cattle he examined in an outbreak of verminous diseases in Texas. The losses from this and other worms in mixed infections amounted to 50 per cent in two herds, and a total of at least 10,000 cattle for the year. Some years earlier Detmers (1883) stated that this worm and the lung worm do

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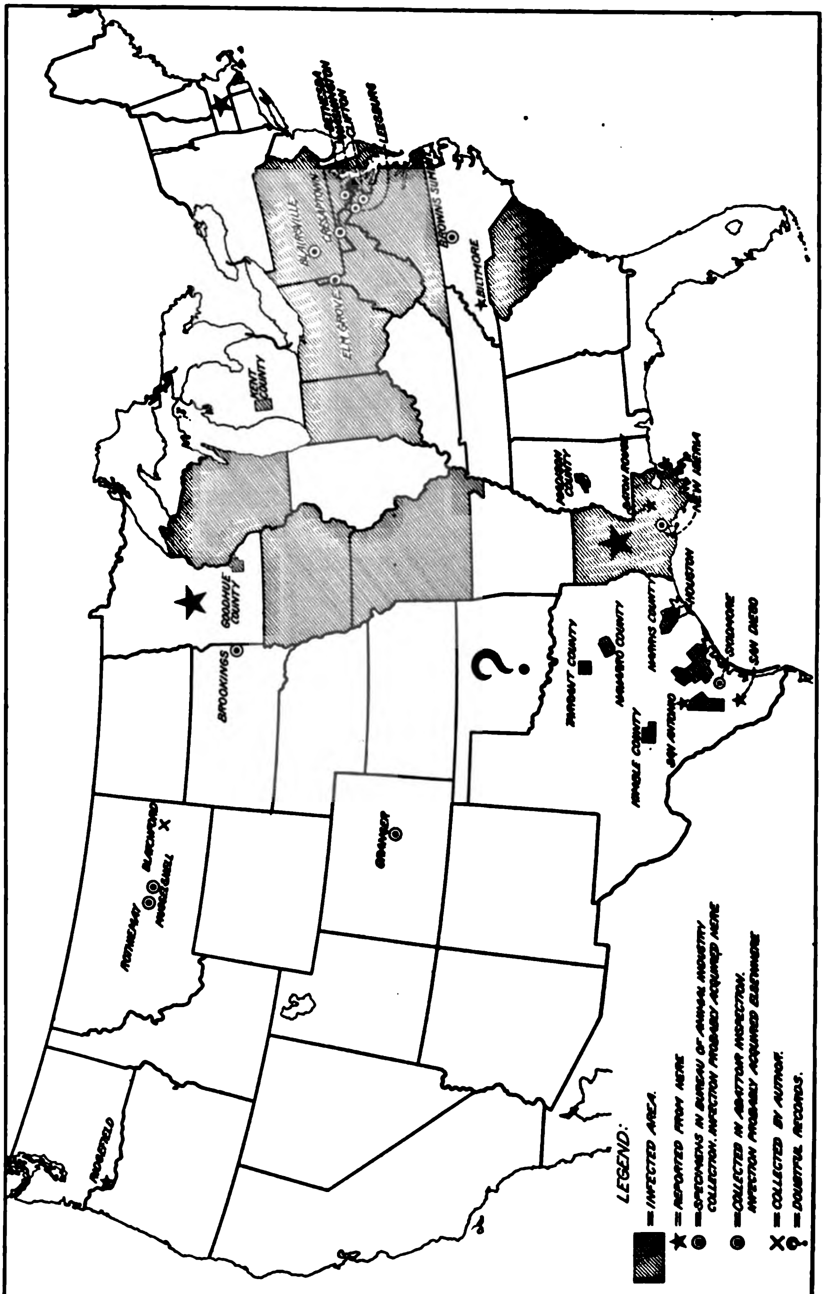

FIG. 55.—Map showing infection with the stomach worm (*Hæmonchus contortus.*).

more damage in Texas than fluke or tapeworm parasites. He states that it causes gastric trouble, emaciation, anemia, and not seldom death. While the Spanish term "lombriz" is sometimes used to denote any verminous infection, he states that the term is restricted properly and commonly to the stomach-worm disease. Detmers saw specimens of the stomach worm taken from a sheep near San Antonio in 1881, which is still further evidence of the early and wide distribution of the parasite in this country.

Spencer (1901) states that in late summer and early fall this worm causes considerable loss in Virginia. Smyth and Niles (1896) say: "In Virginia more sheep are lost annually as a result of intestinal parasites than from all other diseases combined. * * * *Strongylus contortus* * * * and *Œsophagostoma columbianum* are the most common in this State." Of West Virginia, Stewart and Atwood (1903) say: "Stomach worms * * * seriously interfere with successful sheep husbandry in this and other sections of the country." Wheeler (1903) notes that in North Carolina 66 of the Biltmore flock of Southdowns and Southdown grades were killed by this parasite in six months. This parasite and nodular worm were found to be responsible for loss of sheep at Brown Summit, in North Carolina, by Dr. Graybill of this laboratory. In South Carolina, Klein (1905) says the disease prevails quite extensively and causes many deaths. Phares (1889) has recorded the stomach worm from Mississippi.

Paige (1906) says this parasite was not recognized in Massachusetts prior to 1902, but was found in sheep and goats that year. During the four succeeding years six flocks ranging from 20 to 150 in number had been observed and had lost from a few animals to the entire flock as a result of stomach-worm disease. Lewis (1902) implies that this parasite occurs in Oklahoma, but does not definitely say so.

The Middle West has suffered considerable loss from the stomach worm. In Ohio, Wing (1898) states that it "is undoubtedly responsible for most of the deaths among our lambs." Mr. Wing has since made every effort to arouse interest in this parasite. From Indiana, Craig and Bitting (1903) write:

> From an economical standpoint, it is the most important of all the parasites in this State. Probably the average annual loss that may be attributed to this cause will be about 30,000 head. The parasite is to be found in greater or less numbers in nearly all flocks.

Of Iowa, Niles (1897) says:

> In this State the stomach worm has caused more or less trouble for several years, and during the past two years serious losses have occurred in many sections of the State. During the past season this trouble has been reported from many counties and in many flocks the fatality has been very high. It is safe to say that during the year 1896, the stomach worm caused greater loss in Iowa than all other sheep affections combined. One breeder reports losing 55 lambs out

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of a flock of 180; another 40 out of 100; another 24 out of 45; another 105 out of 135; another 40 out of 50. Many others reported heavy losses. It seems evident from the increased number of diseased flocks reported from year to year that this parasite is rapidly becoming more widely disseminated among our flocks. This matter is easily explained, for many of those engaged in breeding fine sheep have lost heavily, and animals purchased from these flocks have served to contaminate others.

The report of the Minnesota State live-stock sanitary board for 1908 states: "Stomach worms of sheep have caused more or less loss to flock owners." Hopkins (1900), writing of Wisconsin, reports that it causes losses of 15 to 60 per cent, one farmer losing 180 out of 400 in spite of worm medicines. Marshall (1910) reports losses from Kent County, Mich.

The writer has already cited cases where the number of stomach worms found by him in sheep examined at this laboratory in connection with some of Dr. Ransom's experiments was as high as 3,915 in one case, and 4,350 in another. The worms were not actually counted, owing to the difficulty of doing anything of the sort, but the number of worms in a cubic centimeter was counted and this number multiplied by the number of cubic centimeters of worms present. Checking this method showed that it gave fairly accurate results. It gives data that are much more satisfactory than a statement to the effect that post-mortem examination disclosed hundreds or thousands of worms. It can readily be seen that something like 4,000 worms would abstract quite a large amount of food material and blood from the host. It is further believed that these worms secrete a toxin which exerts its poisonous effect upon the host animal, and the amount secreted by so many worms must be considerable.

Œsophagostomum columbianum.

This parasite, commonly known as the nodular worm, from the intestinal nodules caused by it, and the nodular disease itself were first described by Curtice (1890 c). He notes that the disease, commonly known as "knotty guts," had previously been observed in the South by Dr. Salmon, and that Dr. Theobald Smith had made some investigation of it in the winter of 1886–87. The adult worms live in the upper part of the large intestine of the sheep, or, according to some writers, in cattle. Ransom (1911) states that in all cases examined by him the nodular worm of cattle was found to be another species. The female worm attains a length of about five-eighths of an inch (15 millimeters), the male being a little shorter (see fig. 56). The worms have a characteristic solid white color which differentiates them from most of the other sheep parasites, which are somewhat translucent, yellowish, or, in the case of the stomach worm, red, The head is bent over and forms a hook with

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the body. The parasite appears to be a native of this country which has adapted itself to our sheep.

The life history of this worm is not completely known. The eggs produced by the females are passed with the feces of the host. When the resulting embryos again come to light they are found in tumors in the mucous lining of the intestine. Here they form cysts which become surrounded by necrotic material due to the resulting inflammation. (See Pl. XXXVI, fig. 2.) The cysts break down and the embryos live in the necrotic mass. After a time they break from the tumors and attain maturity in the lumen of the intestine. It appears that the formation of tumors may not be essential to the development of the worm, and perhaps the stage in the intestinal mucosa is entirely omitted at times. The writer in one instance found 29 nodular worms in the intestines and only 1 nodule visible. This might be taken to indicate that nodule formation is not essential but only incidental to the development of the worm. Curtice (1890 c) has made similar observations, and surmises that this species develops normally in the lumen of the intestines; that some embryos penetrate the walls of the intestines and even get to the mesenteric glands, the liver, or the omentum; that those which penetrate the wall of the intestines may develop slowly and at length get to the lumen of the intestine, or may die; that this tumor-making stage of the life history may favor the survival of the species by providing slowly developing forms which pass the winter there and mature in spring at a time when the eggs spread on the pastures will better serve the purposes of infection; and that worms penetrating the walls of the intestines too deeply, such as those attaining the omentum or the liver, perish. On the other hand, there is a possibility which Dr. Ransom has suggested to the writer, that the embryos normally penetrate the intestinal walls, and in the course of their development give rise to lesions which are so small as to be readily overlooked in the course of macroscopic examination, and which heal promptly on the escape of the worm. The formation of the large nodule would only follow, then, in the case of embryos which penetrate too deeply, as Dr. Curtice suggests, or perhaps when complicated by the action of bacteria.

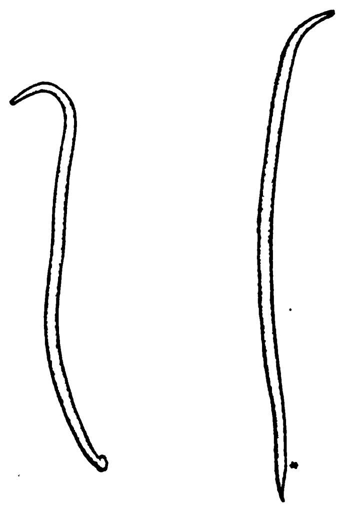

FIG. 56.—The nodular worm (*Œsophagostomum columbianum*). Enlarged. * Vulva. (From Bureau of Animal Industry Bulletin 127.)

As an economic factor, this parasite is confined to the Eastern, Southern, and Middle Western States. (See fig. 57.) There does not seem to be sufficient evidence available to warrant Dalrymple's (1904) statement that "there is hardly a State in the Union that can claim freedom from it among its flocks." The writer has never seen a case in the examination of hundreds of Colorado sheep, and has not even found it recorded from west of Minnesota in the north and Texas in the south, although this is more likely to be due to the parasite being uncommon in such States as Kansas rather than to its being absent, as it seems unlikely that a parasite with a simple life history would fail to infect at least some small areas in the general east and west shipments of sheep for feeding, breeding, or slaughter. It seems true, however, that the western plains and the Pacific coast are so free from this worm that they may be declared uninfected. In the writer's opinion, the Southern and Eastern States not shown to be infected on the map, with the possible exception of some New England States, are probably infected and we merely lack printed records, or perhaps investigation, to show this.

Curtice (1890 c) says of this parasite:

> Dr. D. E. Salmon, Chief of the Bureau of Animal Industry, who at one time lived in the South, performed many post-mortem examinations on diseased sheep, and found nothing but these intestinal tumors to account for the severe symptoms of disease which they exhibited, and has verbally stated that he believes this malady is the chief obstacle to successful sheep husbandry in some portions of the Southern States. * * * Dr. Salmon believes that the disease may bring death to its victims in the severest cases. My own observations have been confined to the abattoirs, where saleable animals only are brought. * * * The most seriously affected sheep found in the abattoirs are noticeably poorer, and one would be tempted to believe, were he to judge from the "knotty" viscera, * * * that such animals should have died from the disease long before. These sheep usually have diarrhea, a disease which weakens the affected animals.

These early conclusions of Curtice's as to the injuriousness and importance of the disease have been confirmed and strengthened by later workers. Of Virginia, Smyth and Niles (1896) say:

> This parasite is exceedingly common in this State. In fact, it is quite difficult to find a sheep which is entirely free from it. * * * The writer * * * has met with instances in which over half of large flocks of sheep have been lost as a result of this worm.

Dalrymple (1901) says:

> It appears to be quite prevalent throughout the South, and at times very few sheep are butchered that are entirely free from this knotty condition of the bowels, which renders the intestines unfit for sausage casings.

Dalrymple has published a number of studies of the "bare-lot" method of eradication. As already noted, Dr. Graybill has found this parasite and the stomach worm causing losses among lambs at

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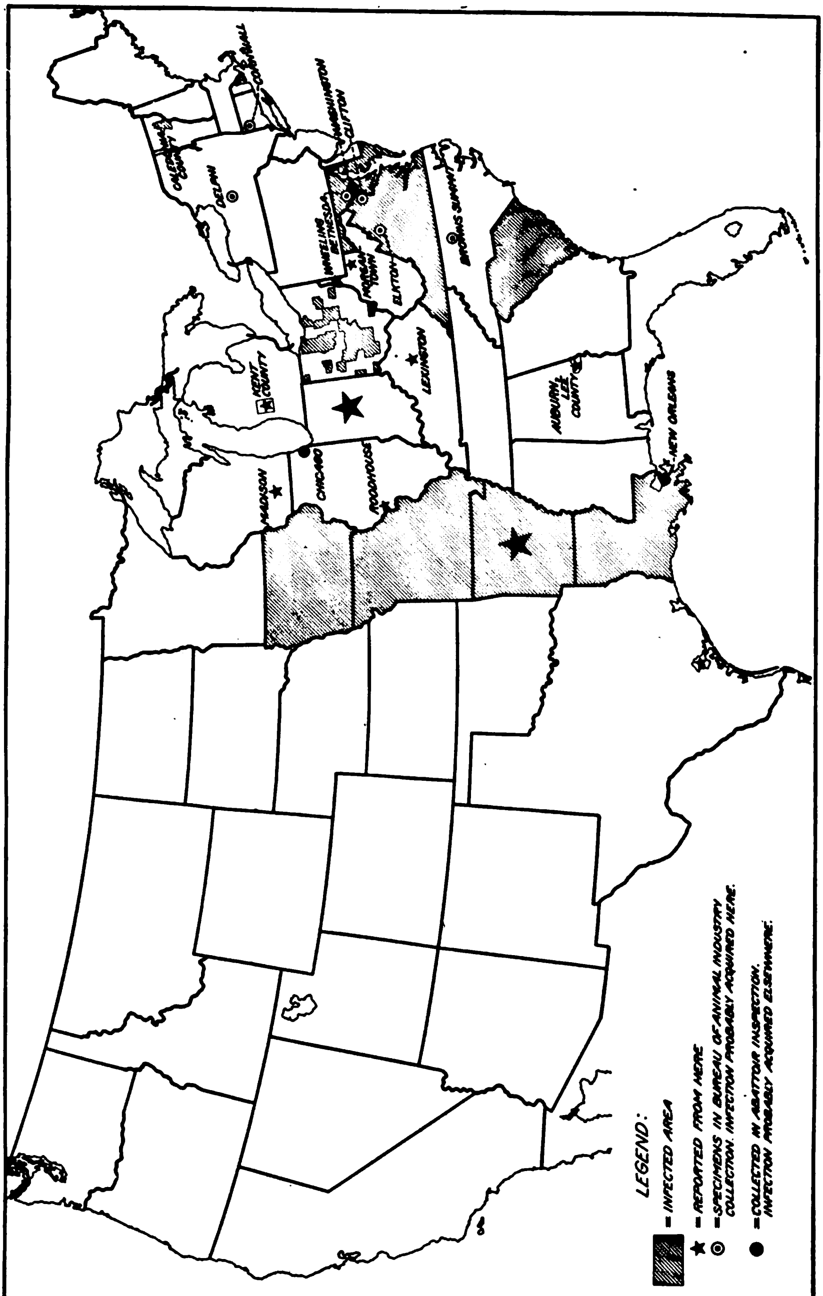

FIG. 57.—Map showing infection with the nodular worm (*Œsophagostomum columbianum*).

Browns Summit, N. C., in 1909. He has also found it near Wheeling, W. Va., in 1908, and at Auburn, Ala., in 1907. The findings in the last case have been published by Giltner (1908).

The parasite appears to be spreading in the Middle West. Craig and Bitting (1903) indicate the presence of nodular disease in Indiana, and say: "This peculiar disease has not been known for very many years and seems to be gaining its foothold quite rapidly." The live-stock commissioners of Ohio in their report for 1904 made their first mention of the disease, as follows: "The disease occurs only in a few localities in this State. In the past year one outbreak was observed near Lockburn." The following year, 1905, they reported:

> Not many years ago nodular disease in sheep was unknown in Ohio; it is now reported more frequently from year to year and is becoming very destructive to sheep in several sections of the State. * * * The disease frequently terminates in death, and in other cases it permanently affects the general health of the animal. Once introduced on a farm, it is a difficult matter to exterminate it. Its treatment is very unsatisfactory. * * * The best preventative is the observation of care in the purchase of new stock. Farms free from the disease should not be stocked with sheep from the infected areas.

This last point is one which the writer has already emphasized in connection with the desirability of a knowledge of the distribution of parasites. The commission printed a map showing that 7 counties were infected. The report for the next year showed 13 counties infected, the next year 15, the next 25, the next 26, and their last report, published in 1910, showed 29. In this report they say:

> Twenty years ago this disease was unknown in Ohio. To-day it is common in 29 counties, and probably present to some extent in every county where sheep are raised. The losses from this disease are probably as serious as those from tuberculosis in cattle. We know very little about effective remedies for the trouble. Once a pasture has become infected, sheep should be kept off for several years until the worm parasites die out. A few thousand dollars spent in the investigation of remedies for this trouble would be a paying investment for the State.

The work of this commission in mapping the infected areas in the State of Ohio is a model which it would pay other States to copy.

Niles (1897) refers to this disease in Iowa as follows:

> In this State it is very rare to find a sheep over 8 months of age that does not show some indications of the trouble. * * * In a number of instances where serious loss has occurred in flocks in different parts of the State, no other cause of death could be discovered. * * * When the affection does not produce a fatal termination, the loss from unthriftiness, partial failure of the wool crop, and the rendering of the intestines unfit for sausage casings, is by no means trivial.

The parasite is recorded from West Virginia by Stewart and Atwood (1903), from South Carolina by Klein (1906), from Wisconsin by Hopkins (1900), from Michigan by Marshall (1910), from Vermont by the State Board of Agriculture of Vermont (see Bell,

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1900), from Arkansas by Dinwiddie (1892 b), and from Texas by Stiles (1902 a). Dr. Luckey writes me under date of March 2, 1911: "It is not uncommon in any part of the State (Missouri) to find *Œsophagostomum columbianum* in either sheep or cattle."

Œstrus ovis.

The sheep gadfly (fig. 58, *a*) is seldom seen in the adult stage by the sheepman. Riley (1869) describes it as looking "something like an overgrown house fly." It has no mouth and hence does not feed, the principal purpose of the animal at this stage being that of reproduction. After the mating of the male and female flies, the female deposits its larvæ, already hatched from the eggs, inside the nostril of the sheep. The larvæ are provided with hooks, and by means of these they work their way up into the nostril of the sheep. The larvæ develop into grubs, which attain a length of three-fourths of an inch (20 millimeters) (fig. 58, *b*). The larvæ are first white, but later become yellow, and finally a dark yellow with a black band on each segment, and the segments armed with black spines. This is the stage in which the parasite is most commonly seen and described. At the proper time this grub escapes from the nostrils, falls to the ground, and bores its way underground to a depth of 1 or 2 inches. After a period, which varies with the weather conditions, the mature fly emerges from its pupal case and makes its way to the open air.

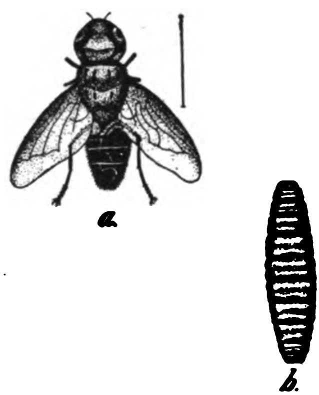

FIG. 58.—The sheep gadfly (*Œstrus ovis*). *a*, Adult fly. (After Brauer.) *b*, Larva or grub from nose of sheep. Enlarged. (After Curtice.)

As the larvæ crawl around over the sensitive mucous membrane of the sheep's nostrils, they cause considerable irritation. This results especially from the sharp spines on the ventral surface, which cause minute hemorrhages where they puncture the mucosa. The grubs work their way back to the passages of the turbinated bones and into the frontal sinuses. Curtice (1890 c) states that some of them become entrapped among the windings of the superior turbinated bones and in the orifice leading to the superior maxillary sinus, the grub increasing in size to the point where it is unable to return by the passage it entered as a smaller larva. The irritation caused by the grubs causes a catarrh, from which the disease due to the grub takes the name of "snotty nose." Worse than this is the fact that the inflammation set up in the nasal mucosa causes an irritation of the nerves of smell, and the inflammation is trans-

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mitted along the short course of these nerves to the brain. When the grubs are numerous the effects on the sheep are serious and at times fatal. The catarrh is accompanied by considerable sneezing and snorting. Later the animal shakes its head or rubs its nose on the ground. It walks with a peculiar gait, similar to that of some giddy sheep, but does not show the circling or the other repeated automatic actions of typical giddy sheep. The affected animal becomes emaciated and may die in convulsions. As a rule, it is able to survive the attack until the escape of the larvæ from the head. and then the symptoms abate and the animal recovers. Curtice (1890 c) states that the largest recorded number of grubs from the head of a sheep is 60 to 80.

It is still a moot point, and one on which positive evidence would be welcomed, as to whether the larvæ ever penetrate to the brain of the sheep. Riley (1869) states that according to reliable sheepmen the parasite may enter the brain. Curtice (1890 c) says: "The larvæ of the *Œstrus*, or the grubs, never do and never can penetrate into the brain." The former is an opinion commonly entertained by sheepmen. Both positions have been maintained by veterinarians. Quite recently, Blasi (1910) reports that in a post-mortem examination of a sheep he found a typical larva of *Œstrus ovis* in the right lateral ventricle. There was an eccentric dilatation of the ventricle, considerable augmentation of the cephalo-rachidian fluid, with amaurosis and lesions of the optic lobes and the neighboring regions.

Riley (1869) reported that this grub was present "in the head of almost every sheep that dies, in the Western States at least." This statement is presumably based on probabilities, in large part, rather than on actual observation or printed records. While it is probably true, it is nevertheless desirable that we have definite information on this point, and at the present time there are some States from which the writer has found no records. The existing records, showing the parasite on both coasts, along the Canadian border States and the Gulf, and through the interior, indicate that the distribution of the fly is in a general way coincident with the distribution of the sheep (see fig. 59). A study of this distribution might disclose exceptions which would be indicative of means for minimizing or avoiding infection.

Gordon (1883) quotes a sheepman in Monterey County, Cal., who says that "worms in the head" is the only fatal disease. This refers to the *Œstrus* larvæ, or "grub in the head," presumably. Riley (1869) refers to observations made by various persons in Illinois. Luckey (1908) says of Missouri, "there is probably no flock in the State entirely exempt from it." Gordon (1883) states that this disease is a source of limited loss in the State of Montana. The writer has been told by Dr. Ketchum, of this bureau, that at the St.

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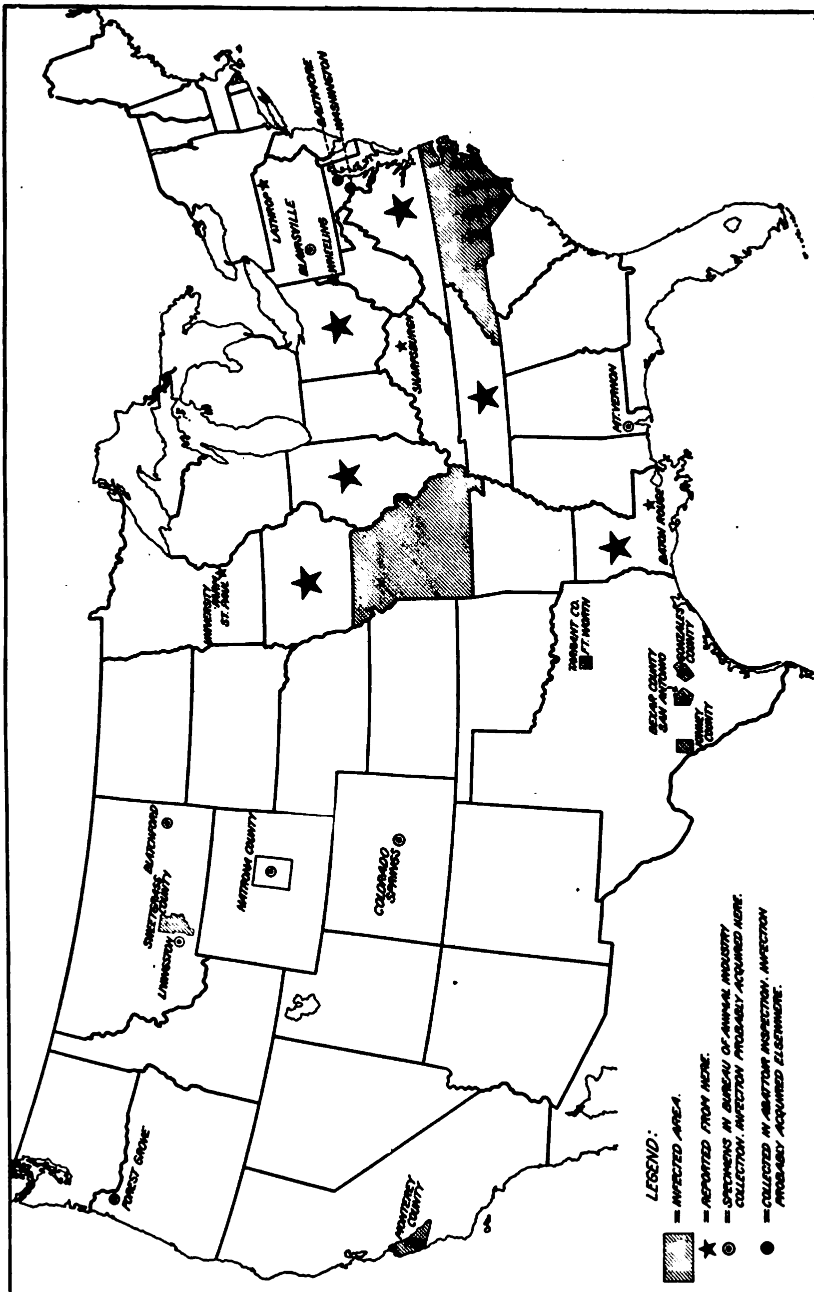

FIG. 59.—Map showing infection with the sheep gadfly (*Œstrus ovis*).

Paul abattoirs the degree of infection of sheep from Sweet Grass County, Mont., was notable, and sheepmen in this county assured the writer that "grub in the head" was perhaps their most serious pest. Butterfield (1900) found it in a flock of 125 sheep in Pennsylvania, and it appeared that this parasite had caused the death of 50 in this flock in three years. Riley (1869) implies the presence of the parasite in Tennessee. Of Texas, Gordon (1883) says, "One owner reports losses from grub in Kinney County," and Detmers (1883) says: "The only real drawback to sheep raising in Texas * * * is caused by the blowfly, and perhaps, also, though in a much less degree, by the gadfly, *Œstrus ovis*." Wing (1898), writing from Ohio, says: "'Grub in the head' has never, in my experience, done noticeable injury to the flock." Niles (1897) says: "The loss in Iowa caused by the sheep bot fly is not heavy." Wheeler (1895) records the death of 117 out of 239 sheep in one flock, and 200 out of 459 in another, where this parasite was the only apparent cause. The sheep had been shipped into Louisiana from Texas, and had apparently been infected in Texas. The fly seems to be plentiful in Louisiana, however, as Dalrymple (1903) says that he has extracted 42 larvæ from the head of one sheep, and thinks that this number is not the maximum for this State. The fly has been recorded from North Carolina by McCarthy (1896), and from Minnesota by Lugger (1896). Dr. Graybill has found it in sheep near Wheeling, W. Va., in 1908, and the writer has collected it this year (1911) in a sheep from Pluck, Va. Herrick (1899) leaves us in doubt as to Mississippi. The writer found about 10 to 20 per cent of the sheep infected in some flocks in Elbert and El Paso Counties, Colo., in 1911. The infection was light in all cases seen. These Colorado records are not shown on the map.

Psoroptes communis ovis.

The parasite which causes common sheep scab is a small mite (fig. 60) easily overlooked on the sheep, but readily visible to the naked eye when the mite is placed on a dark surface. According to Salmon and Stiles (1898), the life history of the parasites is substantially as follows:

The female mite lays about 15 to 24 eggs on the skin of the sheep, or fastened to the wool near the skin; six-legged larvæ are hatched; the larvæ cast their skin and become mature; the mites pair and the females lay their eggs, after which they die. The mites molt three or four times. They multiply with great rapidity, and Salmon and Stiles figure that with 15 days as an average for each generation of 10 females and 5 males the sixth generation would appear in three months' time, and would consist of about 1,000,000 females and 500,000 males.

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FIG. 1.—A WELL-DEVELOPED CASE OF SHEEP SCAB DUE TO THE COMMON SCAB MITE (PSOROPTES COMMUNIS OVIS).

FIG. 2.—VISCERA OF SHEEP, SHOWING MODERATE INFECTION WITH NODULAR WORM (ŒSOPHAGOSTOMUM COLUMBIANUM). (ORIGINAL.)

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The mites bite the skin of the sheep, and apparently introduce some irritating substance into the wound, for the bites cause intense itching, with irritation, formation of papules, inflammation, exudation of serum, and the formation of crusts or scabs. As the parasites multiply, they spread out along the edge of the scab and attack the healthy tissue there. Here is where they may be found most readily, only a few remaining in the scab or crust. The sheep become restless and scratch and bite themselves, or rub against other objects in order to relieve the itching. The wool becomes matted, and is pulled off with the crusts rubbed off by the sheep. (See Pl. XXXVI, fig. 1.) The skin becomes inflamed and thickened. In the course of 2 or 3 months the disease may have spread over the entire body.

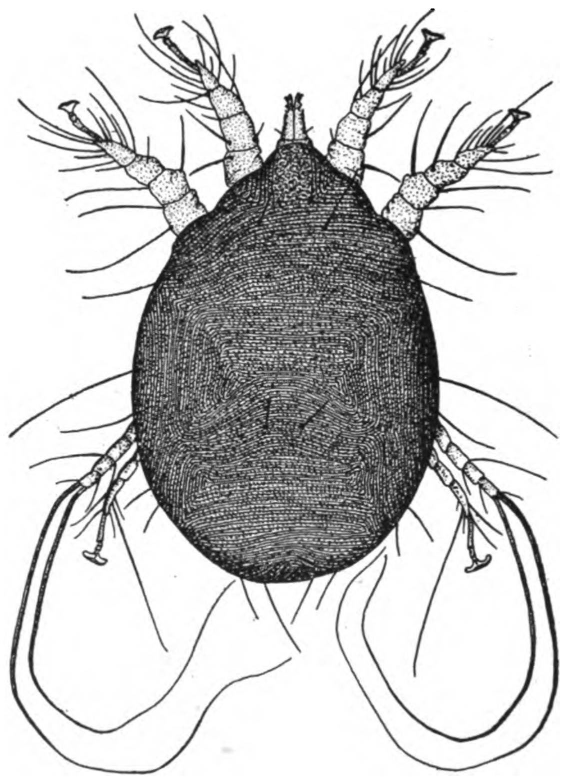

FIG. 60.—The common scab mite of sheep (*Psoroptes communis ovis*). Enlarged. (After Bureau of Animal Industry Bulletin 21.)

The disease is highly contagious, and cases may develop within a week after exposure to infection. It is spread by the infected sheep and by means of wool, scab, bedding, or any thing that can carry the mites to another sheep. The infected sheep become anemic and emaciated. Unless treated for the disease they become more and more exhausted, and finally die, only a few making a spontaneous recovery. It is quite likely that the effect of the scab mite itself is complicated by the inoculation of streptococci or staphylococci incidental to the puncture of the skin by the mite, as has been found to be the case in demodectic mange of the dog.

This highly important disease results first of all in a loss of wool, a thing which insures the attention of the western sheepman, who commonly breeds for wool first of all. It does not even permit the

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sheepman to save the pelt, that last saving which is looked after when western sheep die of almost any other disease or after the disastrous "pile ups" of winter storms. The unthrifty sheep ceases to be valuable as mutton. Finally, there is the loss from death, which Salmon and Stiles (1898) say amounts to from 10 to 80 per cent of the flock attacked.

Curtice (1890 c) says of scab:

Of all the diseases of sheep in this country, scab is the most feared by the flockmaster. So insidious is its attack, so rapid its course, so destructive its effects, and so difficult is it to exterminate that it has justly earned the distinction of being more injurious than any other disease caused by external parasites. Scab alone, of the parasitic diseases, has become the subject of legislation in most countries, and yet, if proper precautions were taken and a rational treatment followed, this disease could soon be completely eradicated.

Salmon and Stiles (1898) say:

Many persons engaged in the sheep industry have been forced to forsake it because of their losses from this disease. It is probable that in its destruction of invested capital sheep scab is second only to hog cholera among our animal diseases. * * * In addition to the direct losses in wool, in flesh, and in the lives of our sheep, we have suffered immensely in our foreign trade because of the prevalence of this disease.

Previous to the establishment of the Federal quarantine on scab, there was almost no place in the United States that could claim more than a temporary freedom from this disease. Such freedom was attained from time to time by some States as a result of the efforts of State officials, but it was difficult to prevent reinfection from adjacent States, and in those cases where the adjacent States were negligent or indifferent it meant that the effort to keep a State clean could never be relaxed until a general effort under the direction of the Federal Government should result in the eradication of the disease. The Western States were constantly infected for the most part. In this connection it is interesting to note that the writer has found a mite indistinguishable from the common scab mite of sheep, on a mountain sheep, *Ovis nelsoni*, according to Dr. Bailey, of the Biological Survey, which was suffering from scab in the National Zoological Park in Washington, D. C. This suggests that this animal may occasionally act as a carrier of the disease in some Western States. This seems more likely from a record of Warren (1910), who notes the death of 75 Colorado mountain sheep (*Ovis canadensis*) from scab contracted from domestic sheep.

The work against sheep scab is such an excellent example of what may be accomplished in combating a disease when its distribution is known and steps are taken to restrict and eradicate it, that the writer has indicated on the map (fig. 61) not only the present infected areas but also the areas formerly included within the Federal

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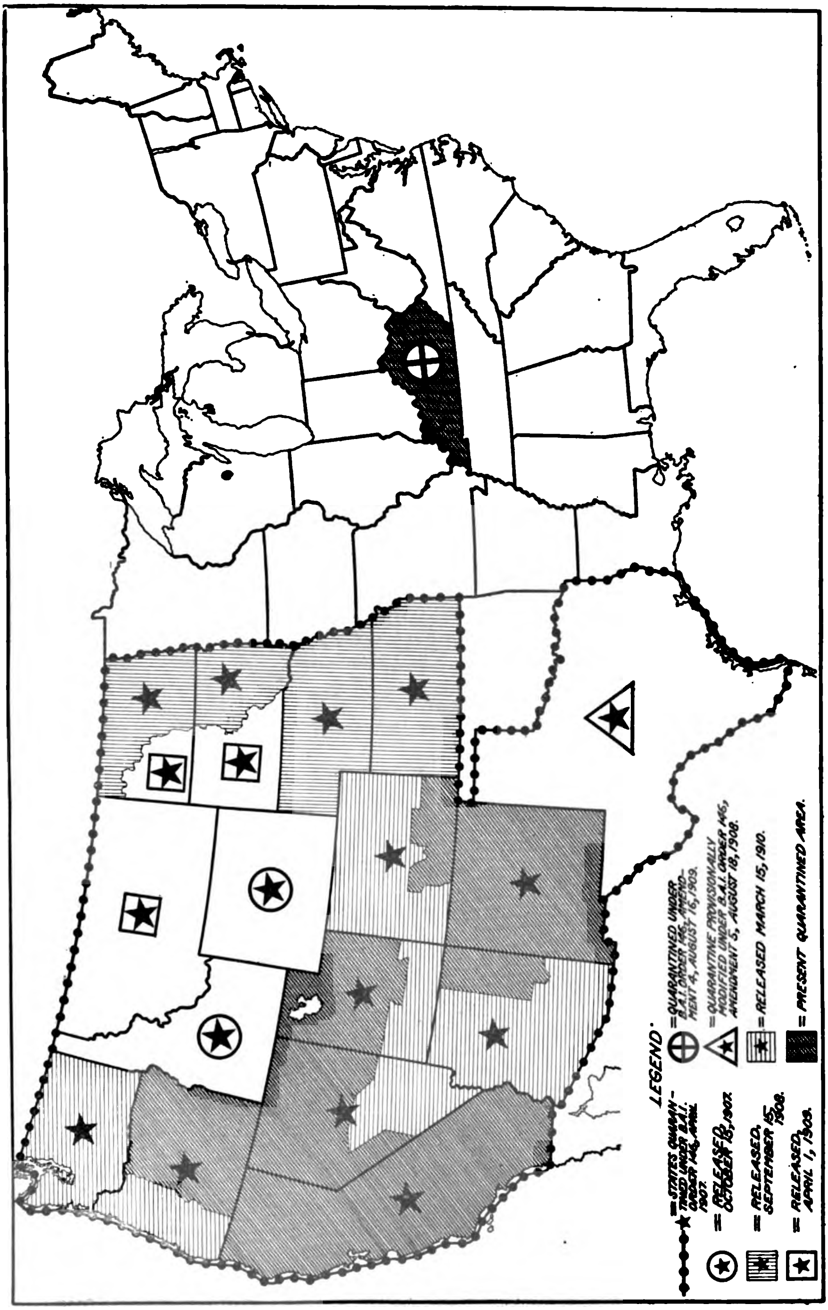

FIG. 61.—Map showing areas quarantined on account of sheep scab.

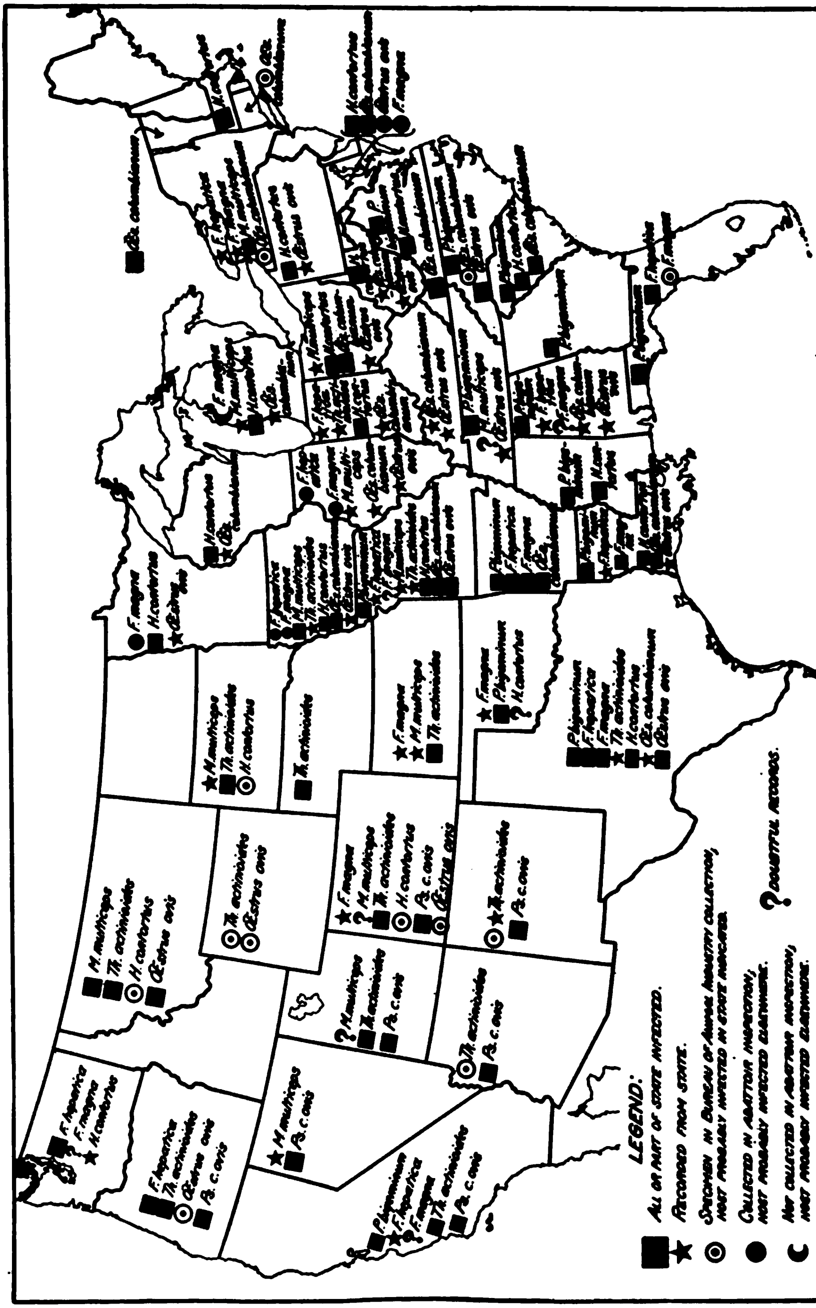

FIG. 82.—Map showing areas of reported infection with various parasites.

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quarantine lines, with symbols to designate areas simultaneously released. The writer is informed by Dr. Steddom, Chief of the Inspection Division of this bureau, that other areas will presently be released. It is expected that ultimately the disease will be eradicated from the United States. The cost of eradication will be trifling compared with the loss saved.

FUTURE RECORDS.

A map (fig. 62) is published here which indicates for each State which of the parasites discussed in this paper have been recorded from that State, together with a symbol indicating the nature of the record. It is hoped that State and Federal employees, and also scientists and veterinary practitioners not in State or Federal employ, will add to this record wherever possible. The Bureau of Animal Industry will greatly appreciate such cooperation, and the information so obtained will in turn enable the bureau to furnish more exact information and more definite suggestions in regard to these parasites than would otherwise be the case.

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THE PROTOZOAN PARASITES OF DOMESTICATED ANIMALS.

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INTRODUCTORY.

Attention was first forcibly called to the Protozoa as causes of disease by Pasteur, who showed that pebrine, the silkworm disease which broke out in France in 1845, was caused by a protozoan parasite. This disease is estimated to have caused a loss to the silkworm industry of France of $200,000,000 up to the year 1867. The silkworms of France, and of other parts of Europe as well, were practically all destroyed, and the industry was only put on its feet again by the importing of uninfected eggs from Japan.

The second great discovery in the science of protozoology was made in 1882 by Laveran, then a French army physician. This was that the cause of malaria in man is a protozoan which invades and destroys the red blood cells, in this way causing the anemia which is one of the symptoms of that disease. The later discovery that malaria is carried from man to man by a mosquito, and in no other way, has enabled medical science to indicate the method whereby it may be eradicated. The association of malaria and swamps has no other signification than that the swamps furnish breeding grounds for mosquitoes.

The third great discovery was that of Theobald Smith, who, working at Washington in 1892, found the cause of Texas fever of cattle to be a blood parasite allied to but not identical with the malaria parasite of man. This parasite also attacks and destroys the red blood cells, causing an anemia so profound that the blood count may fall to one-third or less of the normal. The parasite is conveyed from one animal to another by the cattle tick, and Texas fever can not exist in a region where there are no cattle ticks. Unfortunately for the agricultural interests of the United States, the tick is present throughout the Southern States, and as a consequence almost all southern cattle harbor the parasite in their blood. Since, however, they become inoculated as young calves, when possessing a high degree of resistance to the parasite, they become naturally vaccinated and seldom suffer from the disease in an acute form. On

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the other hand, northern cattle, which are not naturally vaccinated, are highly susceptible, readily acquire the disease, and usually die if they become infected. It follows from this that it is impossible to move cattle with safety from the North to the South or vice versa without taking certain troublesome precautions. This, in itself, is a serious loss to agriculture, and moreover southern cattle, both on account of the constant presence of the parasite in their blood and the presence of sometimes large numbers of ticks on the skin, are thereby debilitated. The cattle tick is estimated to cost the live-stock industry of the United States from $30,000,000 to $50,000,000 a year.

In Africa a disease of man, appropriately termed sleeping sickness, has been known to civilized man for over a century. Originally confined to the West Coast, it has recently spread eastward and is now a serious menace to the development of Central Africa. In 1902 the cause was discovered to be a trypanosome, a flagellated blood parasite belonging to quite a different group from those before mentioned. This trypanosome is carried from man to man by a biting fly. While cases of sleeping sickness have been cured, the disease is ordinarily fatal, and yearly causes thousands of deaths among the negroes of Africa.

The instances above mentioned show very clearly the importance of the Protozoa from the economic standpoint, both as regards disease in man himself and in animals upon which he depends. The group, long neglected, is now being studied by a large number of investigators, particularly in Europe and Africa. In the United States not so much attention has been paid to the Protozoa as pathogenic organisms, doubtless owing to the fact that this country has so far escaped the ravages of the great trypanosomiases. Further, Texas fever, probably the most serious protozoan disease attacking domesticated animals in the United States, is rather easily controlled, owing to the very limited powers of dispersal possessed by the carrier, the cattle tick. Nevertheless, it is impossible to lay too much stress on the importance of the study of the Protozoa as causes of disease.

In the first place, Protozoa probably do a very considerable amount of harm to the live-stock industries in the United States which altogether escapes attention. For instance, a number of protozoal diseases are always enzootic, and hence do not attract as much attention as would be the case with an epizootic. But the sum total of loss caused by a large number of small outbreaks might easily be considerable. In the second place, the immunity enjoyed by the United States to the great animal trypanosomiases of Africa, Asia, and South America is probably more a matter of good fortune than anything else. The impression that these diseases can exist only in tropical countries is wholly erroneous. Their existence and spread depend exclusively upon the presence of the proper carrier, which appears in all cases to

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be a fly, and in the warm season flies are just as abundant in this country as they are in Asia, Africa, or South America.

It so happens that the tsetse flies, which act as carriers for the African trypanosomiases, are not present in the United States, and accordingly it is generally supposed that there is no danger of these diseases spreading here, even were they to be introduced. It is by no means certain, however, that the African diseases are absolutely dependent on the tsetse flies, and those of Asia and South America certainly are not, since tsetse flies are not present on either of these continents. It may be laid down as a rule that the presence of any biting fly constitutes a source of danger in the presence of a trypanosomiasis, and, as is well known, biting flies are very abundant in America, common examples being horse flies, the stable fly, and the horn fly.

Therefore the Protozoa are of great interest to the live-stock industry of the United States, and it is the purpose of this article to give a brief account of those which are parasitic, with particular reference to those parasitizing domesticated animals.

DESCRIPTION OF THE PROTOZOA.

As their name indicates, Protozoa are primitive animals; they are, in fact, the simplest known forms of animal life. Like the corresponding forms of plant life, the Protophyta, they are unicellular, and in this respect these two forms differ from all other animals, which are multicellular. The Protozoa, though generally larger than bacteria, are almost all so small that they can be seen only with the aid of the microscope. They are widely distributed in nature, being found almost everywhere, and, like bacteria, some species are free living while others live as parasites upon or within other animals.

A protozoan consists of a mass of protoplasm containing a nucleus. Although so simple in structure, they exhibit practically all of the biological phenomena characteristic of the physically complex higher animals. Protozoa take in food, digest and assimilate it, excrete waste products, grow, and reproduce.

Reproduction is effected in two ways, as follows: (1) By bipartition, or division into two; (2) by endogenous multiplication, or division into many. In the first, the nucleus first divides into two parts, the protoplasm follows suit, so that each daughter cell is a replica of the mother cell, and indeed consists of one-half of it. Division of this sort occurs when the protozoan has reached its maximum size, and is shown by trypanosomes.

In endogenous multiplication the nucleus divides into a large number of small bodies. Each of these then collects around it a small part of the protoplasm, and the mass thus constituted breaks up into a number of small bodies. These are often spoken of as spores. This is the usual mode of division in the Sporozoa.

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Under certain conditions Protozoa conjugate, conjugation consisting in the fusion of two individuals. These are termed the gametes, and when two gametes conjugate they form a zygote. In certain Protozoa, the two gametes are to all appearances exactly alike, whence the process of conjugation is termed isogamy, or the union of like gametes. In others, the gametes differ, whence the process is called heterogamy, or the union of unlike gametes. In many cases of heterogamy the gametes are of very different sizes, in which case the larger is known as the macrogamete and the smaller as the microgamete. Macrogamete and microgamete correspond, respectively, to the egg and spermatozoan of higher animals.

As the result of any one of several influences Protozoa encyst. The active, usually motile, organism becomes inert, assumes a spherical shape, and secretes a resistant sheath, often shell-like. In this condition the protozoan is resistant to drought and can also resist the action of substances which would be fatal to it in the active state. Encystment occurs in the free-living forms as the result of a gradual drying up of the water in which they live. In the parasites it is brought about upon expulsion to the exterior in the excreta of the host. Within its protective cyst wall the protoplasm may be wholly inactive or, more usually, divides into spores.

Ecologically, parasitic Protozoa may be divided into two groups, (*a*) parasites of the cavity or tissue of the alimentary canal, liver, kidney, and other organs, and (*b*) parasites of the blood. In the former case the part of the host invaded is in direct communication with the exterior, and hence the parasites, after completing their cycle of development within the body and becoming encysted, reach the outer world along with the excreta of the host. Once here, it is necessary for the further propagation of the parasite that the cysts get upon the food or in the drinking water of other members of the host species, then to be swallowed and to start a new generation of parasites. In such cases as these the dissemination of the cysts, although wholly a matter of chance, may be effected in any one of a number of ways. The excreta, deposited upon the ground, dry, and the cysts are blown about by the wind; the cysts may get into streams of water and thus be carried long distances; animals contaminate their skins and feet with moist feces, and thus carry the cysts. In addition to these purely natural methods, the cysts are doubtless often carried considerable distances in the course of commercial transactions; for example, by railroads.

Nevertheless, this mode of distribution is by no means so efficient as that occurring in the case of the protozoan parasites in the blood. These have wholly lost the power to encyst, and are altogether incapable of living in free nature. Hence the entire life is spent in the interior of some other animal, and these parasites are conveyed

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from one vertebrate host to another by means of some biting invertebrate. It is evident that when this invertebrate is a flying insect, the parasite may easily be carried far and wide. In more detail, in cases where the parasite upon leaving the host merely falls to the ground, the infection may easily be confined to one pasture or stable or kennel. But when it is taken from the host by a biting fly it may be carried to neighboring pastures, stables, or kennels. In the former case the infection tends to be confined to within one circle, having for its center the point where the infection originally broke out, but in the latter each fly which so infects itself is the center of a circle of infection, and any animal within the range of its flight may become infected; hence there is not one but a great number of circles arranged in a group around the original focus of infection.

GROUPAL DIVISIONS OF THE PROTOZOA.

According to various peculiarities in their structure and mode of life, the Protozoa are zoologically grouped into five classes, as follows: (1) Spirochætida, (2) Flagellata, (3) Rhizopoda, (4) Sporozoa, (5) Ciliata.

Of these, the Sporozoa are exclusively parasitic, while both spirochætes and flagellates contain a large number of parasitic forms. The remaining groups, the rhizopods and ciliates, are nearly all free-living forms.

SPIROCHÆTIDA.

A spirochæte (fig. 63) consists of a long delicate body which ordinarily maintains the form of a corkscrew, hence the name. An undulating membrane, an extremely thin, finlike membrane running along the length of the body and following the curves, has been demonstrated to be present in some species. Delicate filaments or flagella may be present at one or both ends. The nuclear material instead of being massed together is apparently distributed throughout the length of the body in a series of granules.

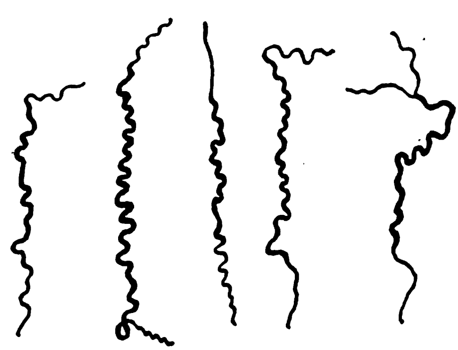

FIG. 63.—*Spirochæta pallida.* (From Doflein after Schaudinn.)

Spirochætes are motile organisms, frequently showing a rapid rotatory movement which may result in progression in either direction. They obtain their nutriment by osmotic absorption from the fluid in which they live. They produce by dividing lengthwise into two. This fact of longitudinal division is the principal reason

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for regarding the spirochætes as Protozoa, rather than as Bacteria, since the latter, when reproducing by division, always divide transversely. In size spirochætes range from 1 micron to as much as 200 microns in length. Hence the smallest are among the most minute forms of animal life, while the largest might perhaps be seen with the unaided eye. So far as known the disease-producing species are nearer the lower limit than the upper limit of size.

The parasitic spirochætes with reference to their mode of life may be classified under five headings, as follows:

1. Inhabitants of the body cavities.
2. Inhabitants of normal mucous surfaces.
3. Inhabitants of inflamed mucous surfaces and ulcers.
4. Tissue parasites.
5. Blood parasites.

This series shows very clearly the way by which the origin of parasitism may be explained from the standpoint of evolution. Beginning with the inhabitants of the organic cavities, such as the intestine, spirochætes live merely as harmless commensals in the contents of these cavities, subsisting upon the food of the host rather than upon its secretions or tissues. The next step is the acquisition of the habit of living on the surface of the mucous membrane, in which case it may be assumed that the parasite subsists upon mucus. A further stage is reached by those forms which live in ulcers or degenerating tissues. The effete products resulting from the decay of the tissues furnish the spirochætes with an abundant supply of food, and in such regions they will multiply with great rapidity.

When the habit of living in ulcers and in tissues in process of breaking down is once acquired, it is an easy step to acquire the power of penetrating healthy tissues, and then of coming to dwell in the more deeply lying parts of the organism. Evidently the multiplication of spirochætes in such situations will cause local disturbances and the destruction of the invaded tissues. The effete products resulting from such tissue destruction, together with those coming from the bodies of such parasites as die, form toxins which, getting into the blood, are the cause of general symptoms.

The final stage is reached when the spirochætes acquire the habit of living in the blood. They then work harm to the organism by the production of toxins, which result from the dissolution of dead parasites in the blood, doubtless combined with substances produced by the parasites in the course of their metabolism.

In the case of the spirochætes which live in the blood, it is evident that transfer can not be by contact, but that the intervention of an intermediate host is necessary. This intermediate host must be a blood-sucking invertebrate, and in the known cases it is a biting bug or a tick.

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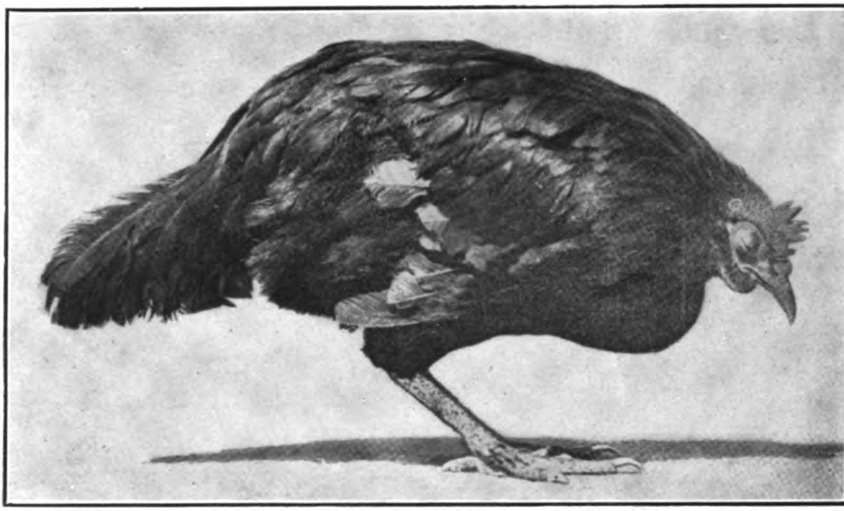
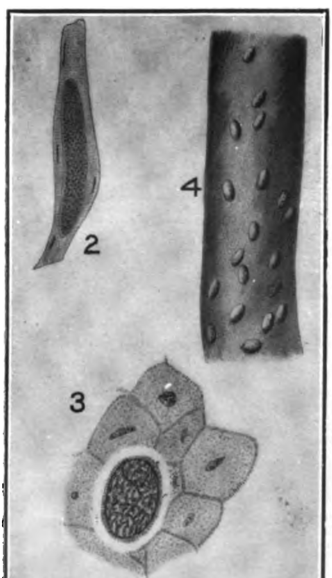
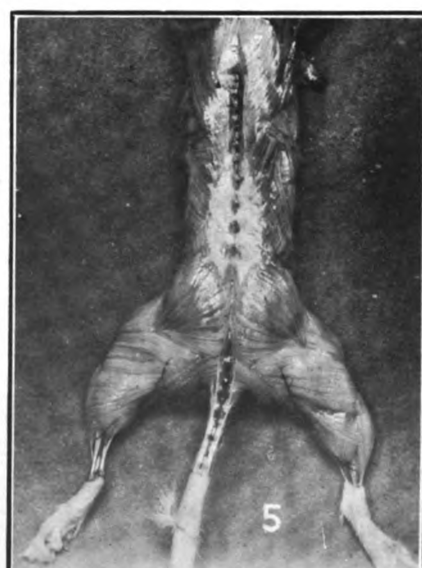


FIG. 1.—A HEN SUFFERING FROM ACUTE SPIROCHÆTOSIS. (AFTER BALFOUR.)





FIGS. 2 TO 5.—VARIOUS FORMS OF SARCOSPORIDIA.

2. *Sarcocystis blanchardi.* Longitudinal section of an infected muscle with young individual. (From Doflein after Van Eecke.)
3. *Sarcocystis tenella* in a Purkinje cell of the heart of a sheep. (From Doflein after Schneidemühl.)
4. *Sarcocystis tenella* in the wall of the esophagus of a sheep. (From Doflein after Schneidemühl.)
5. *Sarcocystis muris* in muscles of mouse.

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In the present state of our knowledge the spirochætes do not seem to be so successful in causing disease in the domesticated animals as are other groups of Protozoa. Although occurring in cattle, horses, and sheep, the diseases produced are by no means severe and seldom result in death. With birds, chickens, and geese the diseases are of a much more severe type and show a large lethality. Even here, however, they are not of general occurrence and do not seem to cause any great loss. Yet the extreme pathogenicity of the spirochætes which are parasitic in man, namely, those causing syphilis, yaws, recurrent fever, and African tick fever, indicates that the group is a dangerous one to all the higher forms of animal life.

Hence it may well be that the spirochætes do much more harm than is supposed. There are a number of distinct diseases of domesticated animals for which the cause is unknown, and furthermore, many animals die of afflictions the symptoms of which are obscure or ill defined. In all such cases it is wholly within the limits of the possible that a spirochæte is to blame.

The following species of spirochætes may be mentioned:

SPIROCHÆTA ANSERINA.

This species is from 10 to 20 microns long, has a very delicate body, and many spiral curves. It occurs in geese, in which it causes a very fatal disease. It may be artificially transferred to chickens and ducks, in the young of which it causes a severe disease. During the incubation period, *S. anserina* lives in the spleen and bone marrow of the goose, later in the blood. The carrier of this species is not known.

SPIROCHÆTA GALLINARUM.

This species is 15 to 20 microns long. Discovered originally in Brazil, it occurs naturally in chickens, but is easily transmitted to geese, pigeons, ducks, and a number of sparrowlike birds. It can not live in mammals. One attack renders chickens immune. This spirochæte is remarkable in that it sometimes penetrates the red blood cells. It has also been found in the epithelium of chick embryos and in the eggs. The carrier is a tick, *Argas miniatus*.

A disease occurs among chickens in the southern United States which shows the same symptoms as the spirochæte disease. Furthermore, it seems always to be accompanied by the presence of the tick *Argas miniatus*, which has been proved to be the carrier of *Spirochæta gallinarum*, so that it is highly probable that the disease is a spirochætosis. Plate XXXVII, figure 1, shows a hen suffering from an infection of *S. gallinarum*.

SPIROCHÆTA THEILERI.

This species, discovered by Theiler in South Africa, measures 20 to 30 microns long by 1¼ to 1⅓ microns wide. It is pointed at both ends.

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It occurs in cattle and is transmitted by the tick *Boophilus decoloratus*. It is pathogenic, but only slightly so, seldom or never causing death.

SPIROCHÆTES OF HORSES AND SHEEP.

Spirochætes have been found in horses and sheep, but little is known concerning them or concerning the diseases which they may cause.

FLAGELLATA.

The Flagellata are rounded or elongated in shape, and are provided with one or more flagella. The form of the body varies a good deal (see Pl. XXXVIII and figs. 64 to 72) and is to a large extent correlated with the number and mode of insertion of the flagella.

The flagella, the characteristic organs of this group, are delicate, whiplike outgrowths from the body, capable of movement in any direction and of the most varied character. In number they range from one to six, or even more. Mostly they project freely from the body, but in some a flagellum forms the border of a delicate membrane running along the body and known, on account of its movements, as the undulating membrane. The flagella which form the border of the undulating membrane may be as long as the undulating membrane, or longer, projecting free.

Flagellates feed in various ways. Some of the free-living forms possess a mouth and cytopharynx, and live on solid food. But the greater number live by osmosis, and this is necessarily the method of nutrition of all the parasitic forms.

The parasitic genera of flagellates are as follows:

Trypanosoma (Pl. XXXVIII).
Cryptobia (=*Trypanoplasma*) fig. 64; Pl. XXXVIII, fig. 16).
Cercomonas (fig. 65).
Herpetomonas (fig. 66).
Crithidia (fig. 67).
Bodo (figs. 68 and 69).
Costia (fig. 70).
Monocercomonas.
Trichomonas (fig. 71).
Hexamitis.
Lamblia (fig. 72).
Polymastix.

As was seen to hold for the spirochætes, there is here also a regular gradation from harmless inhabitants of the cavities of the body up to the extremely pathogenic dwellers in the blood. A large number of forms live in such places as the recta of frogs and salamanders and in the various cavities of fresh-water animals. These, it may be assumed, are just beginning a parasitic life, the character of their

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environment differing but little from that of infusions of organic matter. Such parasites can scarcely be considered as doing any harm to their host, and presumably have selected such an environment on account of its furnishing a constant supply of food.

Other forms (*Trichomonas*, *Bodo*, *Lamblia*, etc.) live habitually in the alimentary canals of the higher animals. These are at times associated with morbid conditions and have then been noticed to become more abundant. It is not, however, supposed that they cause the morbid conditions. Rather it is the other way about, the morbid conditions furnishing a richer and more abundant pabulum which causes a more abundant growth of the parasite.

Finally, in the blood forms belonging to the genus *Trypanosoma* we come to some of the most destructive parasites known.

TRYPANOSOMA.

The form and appearance of the trypanosomes are shown on Plate XXXVIII. The body is elongated and may be blunt or pointed at the ends. Centrally, there is a round or oval body, the nucleus proper, or trophonucleus. Behind this, and usually very close to the posterior end of the body, is a very much smaller body, the centrosome, blepharoplast, or kinetonucleus. From the kinetonucleus arises the flagellum which runs to the surface, emerges, and passing forward forms the border of the undulating membrane. In most trypanosomes the flagellum is longer than the undulating membrane, displaying a free portion which may be as long as the entire body. It is conventional to refer to the end from which the free flagellum protrudes as the anterior end.

Trypanosomes are parasites of vertebrates ranging from fishes to man. They are confined to the blood, lymph, or cerebrospinal fluid, and hence, with one exception to be noted below, the intervention of an intermediate host is necessary for their transfer. In the case of certain of the mammalian trypanosomes the carrier is known to be a fly, and some biting arthropod is probably the intermediate host for the trypanosomes of all terrestrial vertebrates. In all cases where the carrier of the trypanosomes of fishes and frogs has been discovered it is some species of leech.

The transfer of trypanosomes by the invertebrate host is effected in two ways—the indirect or biological and the direct or mechanical. The former is wholly analogous to what takes place in the transmission of malaria by mosquitoes. The fly bites an animal suffering from the disease, taking up a number of trypanosomes with the blood. These are not digested by the fly, but go through certain biological processes, and may apparently even disappear as trypanosomes. At all events the fly, after the first few hours, generally ceases to be

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PLATE XXXVIII.—VARIOUS SPECIES OF TRYPANOSOMA.

1. *Trypanosoma lewisi*, of the rat.
2. *Trypanosoma lewisi*, multiplication rosette.
3. *Trypanosoma lewisi*, small form resulting from the disintegration of a rosette.
4. *Trypanosoma brucei*, of nagana.
5. *Trypanosoma equinum*, of caderas.
6. *Trypanosoma gambiense*, of sleeping sickness.
7. *Trypanosoma gambiense*, undergoing division.
8. *Trypanosoma theileri*, a harmless trypanosome of cattle.
9. *Trypanosoma transvaliense*, a variation of *T. theileri*.
10. *Trypanosoma avium*, a bird trypanosome.
11. *Trypanosoma damoniæ*, of a tortoise.
12. *Trypanosoma soleæ*, of the flat fish.
13. *Trypanosoma granulosum*, of the eel.
14. *Trypanosoma rajæ*, of the skate.
15. *Trypanosoma rotatorium*, of frogs.
16. *Cryptobia borreli*, of the red-eye (a fish).

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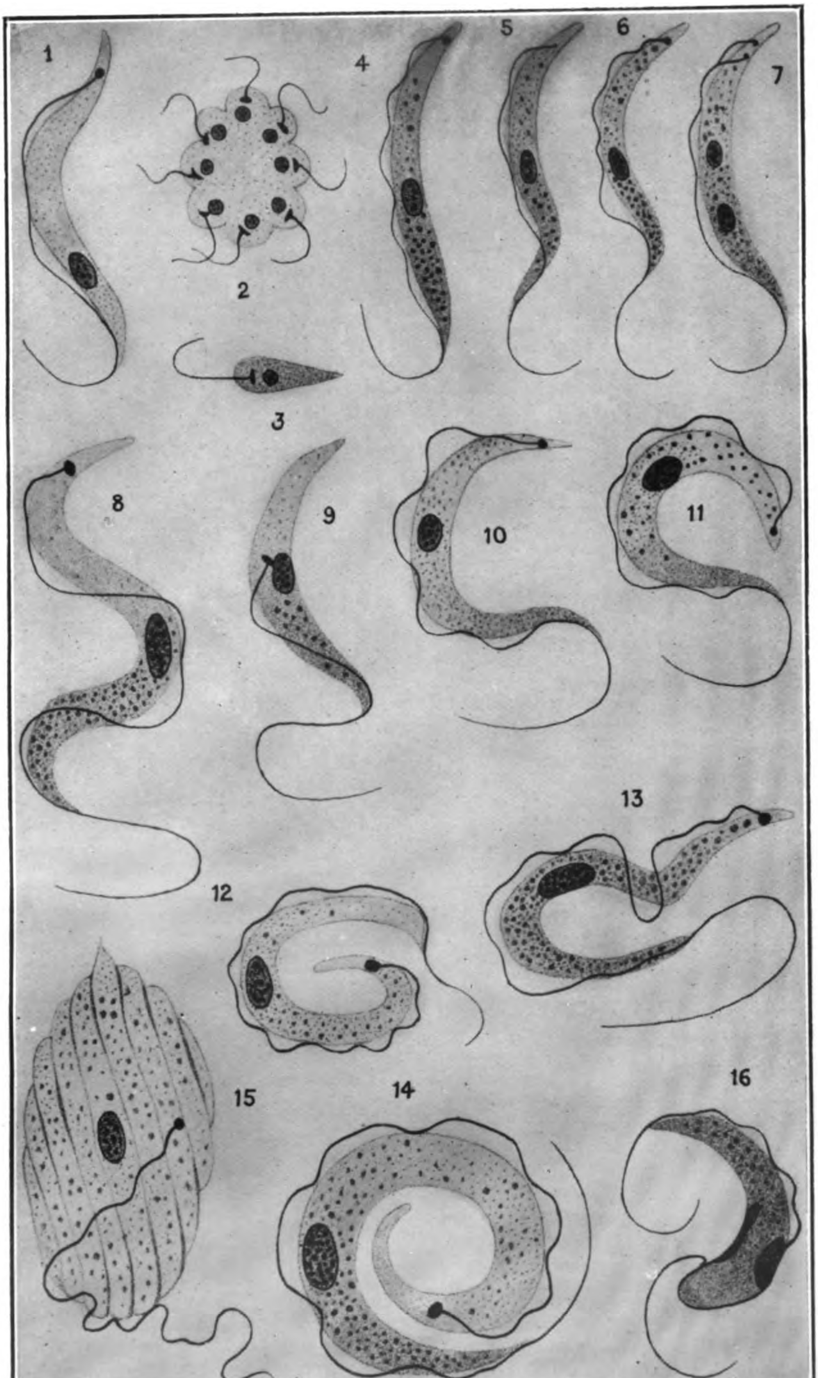

VARIOUS SPECIES OF TRYPANOSOMA. (FROM LAVERAN AND MESNIL.)

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infective, and remains noninfective for a number of days. After this lapse of time, however, the trypanosomes within the fly resume their ability to infect any host which the fly may bite. Moreover, flies which have thus become infective remain so, so far as is known, for the remainder of their lives, the trypanosomes continually multiplying within them. In the experimental work so far done, however, only a small proportion of flies—from 5 to 20 per cent—acquire this permanent infection, although it is believed that in nature this percentage is much larger.

The second method of transfer is the direct or mechanical. If a fly bites a sick animal, and very shortly afterwards a healthy one, the latter may contract the disease. This is due to the fact that as a result of the first bite the proboscis of the fly becomes charged with trypanosomes and these are deposited in the wound made when the fly bites for the second time. The experiment has been tried of permitting a fly to bite a sick animal, and then, successively, two healthy ones. It was found that of the latter the one first bitten usually contracted the disease, whereas the second did not. In other words, the fly cleaned its proboscis while biting the first of the healthy animals. The ability to infect by the direct method is usually lost at the end of a few hours, but has been maintained for as long as two or three days.

In the transfer of a trypanosome by the indirect method, while there may be more than one insect host, these, in the known cases, are closely allied species. This is what we should expect, as it is unlikely that a protozoan, adapted to spend a portion of its life cycle in a fly, could do so equally well in a bug or a tick. This, moreover, is confirmed by observations made on the transmission of the trypanosomes of cold-blooded vertebrates by leeches. Here it has been found that a given species of leech is necessary. In other than the right leech the trypanosomes live for a time, but can not go through the proper developmental stages, and such leeches do not become infective.

In direct transmission it apparently makes but little difference what species of biting arthropod is involved, the essential condition being that the interval between bites be only a matter of a few hours. The fly acts merely as a scalpel or hypodermic needle. Indeed, it has been found that the house fly, which can not bite at all, can transfer surra by sucking alternately a raw surface on a sick and a well animal.

In the blood of vertebrates trypanosomes increase by bipartition, which is always longitudinal. It may be a mere splitting into two generally equal daughter cells, or a sort of rosette formation (see Pl. XXXVIII, fig. 2), which latter, however, is only bipartition in which the daughter cells remain together for a longer or a shorter

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period of time. Nothing in the way of conjugation or encystment has ever been observed.

Knowledge as to what takes place in the intermediate host is meager. Here, in addition to normal trypanosomes, there are flagellates resembling the more primitive cercomonads or herpetomonads. These are presumed to arise from division of the imbibed trypanosomes, but the exact processes taking place in the fly have not yet been worked out.[1]

TRYPANOSOMA GAMBIENSE.

This is the agent of sleeping sickness, and while primarily of interest to human medicine, is also of interest to the live-stock industry, since it has been found to be pathogenic for many other animals besides man. Sleeping sickness seems to have been first described by Winterbottom, in 1803, as occurring in Sierra Leone, on the West Coast of Africa. It was not, however, until a good deal later, from 1860 onward, that it began to attract attention. Between 1891 and 1902 a considerable number of alleged "causes" were discovered, all belonging to the bacteria. A blood filaria was also blamed, and one or two investigators attributed the disease to errors in diet. In 1901, however, Dutton, examining the blood of a European patient at Bathurst, Gambia, recognized the parasite as a trypanosome and named it *Trypanosoma gambiense.* (See Pl. XXXVIII, figs. 6, 7.)

A little later Castellani found a trypanosome in the cerebrospinal fluid of negroes in Uganda. It had not at first been known that the Uganda disease and that of the West Coast were the same, but the discovery of trypanosomes in both suggested their identity, a conclusion which has been confirmed by all subsequent work.

Sleeping sickness, then, ranges from the West Coast of Africa across to Uganda, and as a result of the recent exploitation of this region, is spreading. At present its range is the valleys of the Senegal, Niger, Congo, and Upper Nile Rivers.

The disease shows two phases, the first that of so-called trypanosome fever, the second that of sleeping sickness. The first stage, which may last from a few weeks to several years, is characterized by enlargement of the glands and generally by fever. The trypanosomes are always scanty, and can, as a rule, be found only in gland juice. In the second stage, or sleeping sickness, the marked feature is the gradually increasing lethargy. I quote from the English edition of Laveran and Mesnil, page 374:

> The drowsiness increases, and the patient's attitude becomes characteristic. The head falls forward on the chest and the eyelids are closed. At first the

[1] Very recently, however, it has been shown that in the tsetse fly, *Trypanosoma gambiense* does not undergo any radical morphological changes, and that after remaining for a certain time in the alimentary canal it gains the salivary glands.

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patient is easily aroused from this drowsy condition, but soon he reaches that stage in which he falls sound asleep, almost in any attitude, and under any conditions, especially after meals. These periods of sleep, which become gradually longer and more profound, lead eventually to a comatose condition, from which the patient can be aroused only with the greatest difficulty. It is at this stage that the temperature becomes subnormal and death occurs.

Sleeping sickness is ordinarily fatal, although occasional cures are reported. Besides man, *Trypanosoma gambiense* is pathogenic for a large number of other mammals—monkeys, lemurs, the dog, jackal, cat, rabbit, guinea pig, rat, mouse, jerboa, hedgehog, marmot, horse, donkey, cow, goat, and sheep.

The carrier is *Glossina palpalis*, a species of tsetse fly. Experimental work shows that the fly, after biting an animal harboring *T. gambiense*, is noninfective for a period of some days, after which it becomes infective. There are also reasons for suspecting that other species of *Glossina* can carry sleeping sickness.

TRYPANOSOMA BRUCEI.

In 1895 Bruce discovered that nagana, or the so-called tsetse-fly disease of Africa, was caused by a trypanosome. He writes:

Nagana, or the fly disease, is a specific disease which occurs in the horse, mule, ox, dog, cat, and many other animals, and varies in duration from a few days or weeks to many months. It is invariably fatal in the horse, donkey, and dog, but a small percentage of cattle recover. It is characterized by fever, infiltration of coagulable lymph into the subcutaneous tissue of the neck, abdomen, or extremities, giving rise to swelling in these regions, by a more or less rapid destruction of the red blood corpuscles, extreme emaciation, often blindness, and the constant occurrence in the blood of an infusorial parasite.

Bruce adds that nagana is a Zulu word, and has reference to the state of depression and weakness of the infected animal.

The disease is present generally throughout Africa north of the Tropic of Capricorn, except Tunis, Algeria, and Morocco. As in the case of sleeping sickness, the trypanosome can live in nearly all mammals, and to most of them it is fatal. In rats and mice division proceeds with such energy that the parasites may become as abundant as the red blood cells. The parasite, which is appropriately given the name of its discoverer, is shown in figure 4 of Plate XXXVIII. The carrier is not certainly known, the credit generally being given to *Glossina morsitans*, but *Glossina pallidipes* is regarded as playing perhaps an equal rôle in this respect. As yet, however, no accurate experimental work has been undertaken with these flies.

TRYPANOSOMA EVANSI.

Surra plays the same part in Asia which nagana does in Africa. Surra is a Hindu word meaning rotten. The parasite causing the disease, *Trypanosoma evansi*, was discovered by Steel in 1885. The

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disease occurs naturally in horses, camels, and dogs, and is inoculable into a large number of animals with the usual fatal results. Horses always die, the duration of the disease being from a few weeks up to six months. Camels resist the disease for as much as three years. In India cattle are generally resistant, although harboring the parasite in their blood. When, however, in 1901, the disease was introduced into the island of Mauritius cattle succumbed as easily as horses.

The disease occurs throughout southern Asia from Persia to China, in all of the East Indian islands, the Philippines, Korea, Australia, and in Africa in Mauritius and in Madagascar. Camel surra, under the native name of mbori, also occurs in northern Africa.

The specific carrier is unknown. The tsetse flies are not known in Asia, their place being taken by Tabanids and the ubiquitous *Stomoxys calcitrans*, the stable fly. It has been determined that surra can be transmitted by any or all of these flies, but so far as the evidence goes, none of them are infective for more than a day or so after biting an infected animal, and they thus serve merely as direct carriers.

TRYPANOSOMA EQUINUM.

Mal de caderas, or, more briefly, caderas, caused by the parasite *Trypanosoma equinum* (see Pl. XXXVIII, fig. 5), is a disease which affects horses in South America. The following is taken from the English edition of Laveran and Mesnil, page 293:

> The first sign of the disease in horses is wasting, which rapidly progresses in spite of a good appetite. The temperature is often raised to 104° to 105.8° F. After a variable time it is noticed that the hind quarters are weak, and that the animal drags its legs, the hoofs grazing the ground. These symptoms increase and become characteristic, so that when the animal is made to walk it staggers along, the hind quarters swaying from side to side. On account of this symptom the name mal de caderas, or disease of the hind quarters, has been given to the disease. There comes a time when the animal is unable to stand. If in the stable it leans up against the wall or seeks other support, if in the open it staggers and falls. After thus falling to the ground an animal may live for several days if it be fed; otherwise the inevitably fatal end is hastened by inanition.

The parasite, *T. equinum*, was discovered in 1901 by Elmassian. The only domesticated animals in which caderas occurs spontaneously are horses and, rarely, dogs. But the carpincho, a large rodent, is very susceptible, frequently dying in large numbers, and such outbreaks are frequently the forerunners of epizootics among horses.

The disease ranges throughout the greater part of South America, but is not present in the northwestern part of the continent, nor along the Pacific coast.

Caderas is always fatal to horses, and also to a considerable number of small animals to which it may be artificially inoculated. It has,

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however, little or no effect on cattle, sheep, goats, and swine. If such animals be artificially inoculated, the trypanosomes may remain present in their blood in very small numbers for a longer or shorter time, but no inconvenience is suffered.

TRYPANOSOMA EQUIPERDUM.

Dourine, maladie du coït, or horse syphilis, is a disease of horses which is present more or less throughout the world. It is, however, by no means so important to veterinary science as are other animal trypanosomiases. This disease is peculiar in that there is no intermediate host, the trypanosome being inoculable by contact, like the spirochæte of human syphilis. Infection is usually by coition, and hence only stallions and brood mares are involved.

It was originally supposed that the trypanosome could gain entrance only through abrasions in the mucous membranes, but recent work shows that it is able to work through wholly intact membranes. In general, dourine runs a chronic course, lasting from two to six months, sometimes as long as two or three years. Occasionally it is acute, killing the animal within a shorter period.

Dourine is inoculable to dogs, rabbits, and other animals, but is not pathogenic for as many species as are nagana, surra, or caderas.

Infection being by contact, dourine is easily controlled, since all that is necessary to do is to destroy the infected animals. The problem presents none of the difficulties that come up in the case of diseases like nagana and surra, where not only must the diseased animals be destroyed, but all healthy ones must be shielded from the attacks of possibly infected flies.

TRYPANOSOMA AMERICANUM.

This species, though apparently a harmless parasite, deserves attention on account of its common occurrence among American cattle. Its presence in cattle can usually be demonstrated only by the culture method, the trypanosomes, if present, becoming sufficiently numerous in the tubes in a few days to be found readily by the microscope. It occurs in the United States and also in the Philippine Islands and in Europe.

OTHER TRYPANOSOMES.

Trypanosoma dimorphon causes a specific disease of horses in Gambia and in French Guinea. The carrier is *Glossina palpalis.*

Trypanosoma vivax attacks cattle, sheep, and goats in the coast region of the Cameroons. *Trypanosoma congolense* is pathogenic for sheep and pigs in the Congo Free State.

Other trypanosomes might be mentioned which attack domesticated animals in Africa, where every mammal seems to have several

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parasites bent upon its destruction. It would, however, be only tedious to give a list of all of them.

TRYPANOSOMES OF BIRDS, REPTILES, BATRACHIA, AND FISHES.

In birds trypanosomes are of wide distribution, but generally rare in the individual bird. Practically nothing is known as to their pathogenicity. A French savant, Thiroux, by artificially inoculating Java sparrows with trypanosomes which came from other birds of the same species in some cases produced death. But, so far as our knowledge goes at present, the trypanosomes of birds are of little economic interest.

Fig. 64. — *Cryptobia helicis*. (From Bureau of Animal Industry Bulletin 119.)

Reptiles and batrachians are frequently infected with trypanosomes, but the disease of these animals are not of interest in the present connection.

A large number of both fresh-water and marine fishes are parasitized by trypanosomes. Following, however, what seems to be the usual rule for vertebrates lower than mammals, the organisms are generally scanty in the blood. There is no good evidence that any member of the genus *Trypanosoma* is pathogenic for fishes, yet it would be a leap in the dark to say that none is. So far, the fish trypanosomes have been studied wholly from the zoological viewpoint, the question of their pathogenicity not being taken into account.

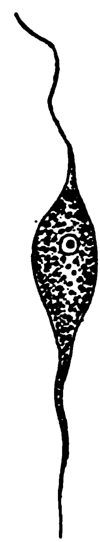

Fig. 65.—*Cercomonas crassicauda*. (After Doflein.)

CRYPTOBIA.

The genus *Cryptobia*, usually known as *Trypanoplasma*, was created in 1846 by Leidy for an organism living in the seminal vesicles of a snail. The members of this genus look a good deal like trypanosomes, but differ in two respects. They are portrayed in figure 64 and in Plate XXXVIII (16). From these it may be seen that there are two flagella, one forming the edge of an undulating membrane, the other projecting freely. In addition, the kinetonucleus, instead of being a small granule, as in trypanosomes, is here a body which may be nearly as large as the trophonucleus. It is the convention to regard the thicker end—the one from which the free flagellum projects—as anterior, although this appears to reverse the relations as they are interpreted in the trypanosomes.

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Cryptobia is not in all cases a blood parasite. The type species, as stated, lives in the seminal vesicles of a snail, and another, *Cryptobia intestinalis*, is an intestinal parasite. Mostly, however, the members of the genus are parasites of the blood of fishes, and some are known to be highly pathogenic.. So far as is yet known, no species of this genus attacks any of the domesticated animals.

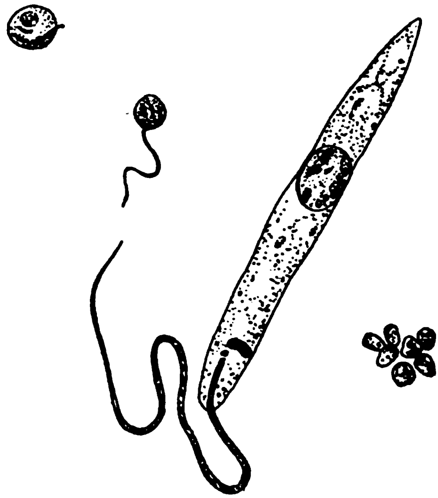

FIG. 66.—*Herpetomonas jaculum*. (After Porter.)

CERCOMONAS.

The appearance of this organism is indicated by figure 65.

A number of flagellated parasites have been credited to the genus *Cercomonas*, but in the main they are poorly described. They occur in the intestines of invertebrates, and of man, the dog, goose, and fowl. Cercomonads have also been said to occur in wounds and ulcers, but in some cases, at least, it is questionable if such observations are authentic. Little can be said as to the pathogenicity of the members of this genus.

HERPETOMONAS.

The species of this genus (see fig. 66) are elongated flagellates with a long flagellum at the anterior end. There is a kinetonucleus, from which arises the flagellum, and a trophonucleus. All are parasites, and so far all have been found in the intestines of invertebrates. They are common in flies and mosquitoes.

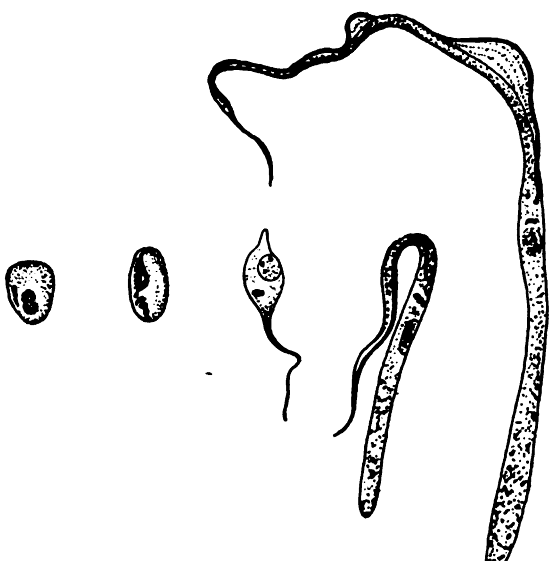

FIG. 67.—*Crithidia gerridis*. (After Porter.)

CRITHIDIA.

Crithidia (fig. 67) is a genus which stands between *Herpetomonas* and *Trypanosoma*. There is a flagellum, a short undulating membrane, a kinetonucleus, and a tropho-

nucleus. The species described are parasites of insects and hence of no special interest in the present connection. In their evolution in culture tubes trypanosomes pass through a crithidial stage, suggesting that *Trypanosoma* has, in its evolution, passed through a *Crithidia* stage.

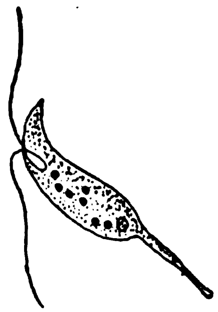

FIG. 68.—*Bodo gryllotalpæ*. (From Doflein, after Grassi.)

BODO.

Bodo (figs. 68 and 69) is a biflagellate organism, bearing a certain resemblance to *Cryptobia*. This comes about from the fact that whereas *Bodo* has no undulating membrane, one of the flagella is usually bent backward and is kept constantly close to the body. There are also, as in *Cryptobia*, two nuclei. All the species of *Bodo* are parasites, mostly of invertebrates. One, *B. urinarius*, has been observed in freshly discharged human urine.

FIG. 69.—*Bodo lacertæ*. (From Doflein, after Prowazek.)

COSTIA.

Costia (fig. 70) possesses three flagella according to some authorities, or four, according to others. The genus is important in that it does considerable damage as a parasite of food fish. But *Costia* differs from all of the other flagellates which have been considered because it is an ectoparasite and lives on the skin and gills. Goldfish, trout, trout embryos, carp, and other fish are attacked. The parasite anchors itself with its long flagellum, becoming so firmly attached that it can be removed only with difficulty.

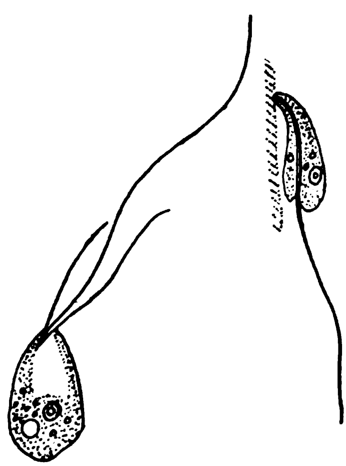

FIG. 70.—*Costia necatrix*. (From Doflein, after Henneguy.)

These parasites may be present in enormous numbers. They provoke lesions of the skin and hemorrhages of the gills. Freshly infected embryos die in two days; goldfish live longer, but slowly succumb. No successful treatment has ever been discovered.

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MONOCERCOMONAS.

This is a small form possessing four flagella. The species are all parasites, living in the intestines of vertebrates and invertebrates. There is no good reason to regard any as pathogenic.

TRICHOMONAS.

This genus (fig. 71) is characterized by the possession of either three or four equally long, free flagella, arising at the anterior end. In those cases where only three flagella are present there arises from the same point of origin an undulating membrane which runs spirally around the body and often is prolonged behind into a free flagellum.

FIG. 71.—*Trichomonas batrachorum*. (From Doflein, after Blochmann.)

Trichomonads occur in batrachia, lizards, snakes, birds, and in many mammals. The various forms occurring in these different hosts are all much alike morphologically, and it is not known whether there are actually few or many distinct species. They are mostly parasites of the alimentary canal, but one form is at times found in the vaginal mucus of *Homo*. Whereas they are at times associated with morbid conditions, there is no reason to suppose them pathogenic.

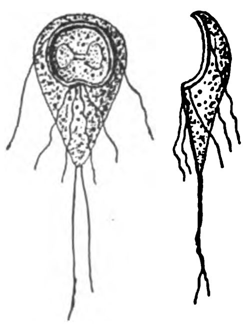

FIG. 72.—*Lamblia intestinalis*. (From Doflein, after Grassi and Schewiakoff.)

HEXAMITUS.

The species of the genus *Hexamitus* are in some cases intestinal parasites, but are apparently not of much economic importance.

LAMBLIA.

Lamblia (fig. 72) lives in the intestines of man and other mammals. In inflammation of the intestinal mucous membrane *Lamblia* becomes very much more abundant, and recent work suggests that such great increases in numbers may cause dysentery. It may be noted also that *Lamblia*, unlike *Trichomonas*, *Bodo*, etc., spends its life upon the mucous membrane rather than free in the intestinal conduits. As shown by the figure, the anterior end of the parasite is hollowed out to form a saucerlike depression, and the flagellate attaches itself to the free ends of the intestinal cells by fitting over them this saucerlike depression. It is accordingly easy to see that when present in large numbers the parasite, by forming a sort of coating on the mucous membrane, might set up disturbances.

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RHIZOPODA.

The general appearance of a simple rhizopod is shown by figure 73, *Amœba proteus*, the common fresh-water ameba. It is seen to show a differentiation into ectosarc and endosarc, the difference between the two being that the ectosarc is somewhat more dense and does not contain granules. Amebas are organisms which continually undergo changes of shape, these changes constituting a type of motion sui generis, which when displayed by other Protozoa and by metozoan cells is spoken of as ameboid. Within the endosarc are the nucleus and contractile vacuole, permanent possessions, and in addition to these food vacuoles and granules of various sorts.

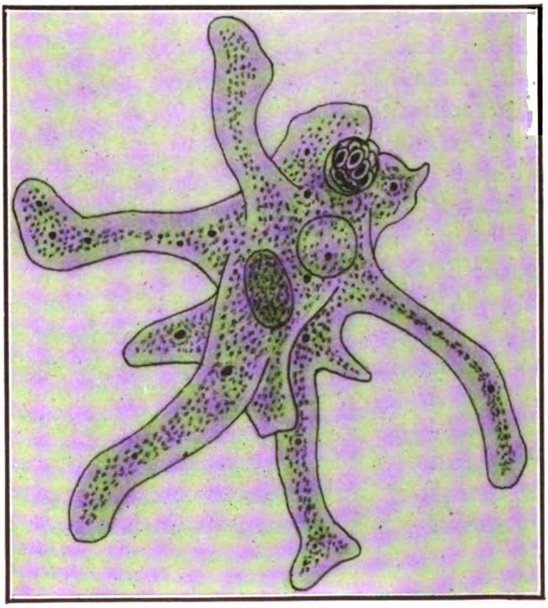

FIG. 73.—*Amœba proteus*. (After Doflein.)

Rhizopods seem always to subsist upon solid food, which is merely engulfed; that is, on coming into contact with a particle of food the ameba merely flows around and incloses it. Within the cytoplasm a certain amount of liquid is secreted around the food particle, thus forming a food vacuole. This liquid presumably holds some chemical in solution, since in the course of time the digestible portions of the food particle are liquefied and absorbed, while the residuum is cast out by a process much the same as that which brought it in.

The known parasitic species are few in number and belong to either one of the two genera, *Amœba* and *Entamœba*. Four species are known to occur in man, one of them the cause of a rather serious disease, amebic dysentery, which is widespread in the Tropics. Ameboid organisms are by no means rare in the alimentary canal of domesticated animals, but there does not seem to be any satisfactorily authenticated case of pathogenicity. *Amœba meleagridis* is the name given by Theobald Smith to an organism found in the liver and cæca of turkeys suffering from blackhead. It is not doubted that a parasite is present in the lesions caused by this disease, but its

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identification as an *Amœba* is questionable. Another doubtful case is that of a fatal disease of sheep, occurring in Australia in 1885. This was credited to an *Amœba*, but the evidence furnished was not conclusive.

THE SPOROZOA.

The Sporozoa are all parasites, and considered as a group are the most dangerous of all disease-producing organisms. They parasitize all classes of animals, from other Protozoa upward, and have at times been recorded in man. The name, Sporozoa, has reference to the fact that these animals reproduce by the formation of spores, which are typically minute, boat-shaped, shelled structures, containing one or more smaller bodies, the sporozoites.

It is taken as an axiom that parasites are descended from free-living animals, and several views have been put forward regarding the ancestry of the Sporozoa. It is found, however, that a hypothesis which may seem plausible for one portion of the Sporozoa fails for the other portion, and hence protozoologists are disposed to believe that the Sporozoa are polyphyletic; that is, that different subdivisions have had different ancestral histories.

Zoologically, the Sporozoa may be divided into two divisions, Telosporidia and Neosporidia, and the somewhat more favored view is that the former are descended from flagellates and the latter from rhizopods. These two groups are distinguished in this way: In the Telosporidia there is a longer or shorter vegetative life, followed by conjugation. The product of conjugation, technically known as the zygote, divides up into spores, and ceases to exist as a zygote. But in the Neosporidia, spore formation is inaugurated quite early in the life history of the individual and vegetative growth and spore formation proceed together.

TELOSPORIDIA.

The only members of this group of interest in the present connection are the Coccidiomorpha, which zoologically are divided into the Coccidia and Hæmosporidia.

COCCIDIA.

The Coccidia are cell parasites, attacking tissue cells and especially epithelium, but never cells of the blood. They are parasites of arthropods, molluscs, and vertebrates. They are distinctly pathogenic for vertebrates, and are doubtless also usually pathogenic for anthropods and molluscs, but the diseases of these last-named animals are not of special economic interest and hence are scarcely known.

Infection of Coccidia is by way of the mouth. Hence, as a rule, it is the epithelium of the alimentary canal and its appendages which

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PLATE XXXIX.—Coccidian Life Cycle.

Figure 1.

1.	Sporozoite, released in intestine of host.
2.	Penetration of sporozoite into epithelium cell.
3, 4.	Growth of sporozoite into trophozoite.
5, 6, 7.	Schizogonous cycle. Nuclear division, followed by division of entire trophozoite into a large number of merozoites.
8.	Free merozoites, which for an indeterminate number of generations merely repeat the schizogonous cycle, behaving precisely as do the sporozoites. Eventually, however, the sporogonous cycle is initiated, which proceeds as follows:
9a.	Undifferentiated female cell.
9b.	Undifferentiated male cell.
10a.	Differentiated female cell.
10b.	Differentiated male cell.
11, 12.	Formation of the microgametes, one male cell producing many microgametes.
13a.	Macrogamete. One female cell produces but one macrogamete.
13b.	Ripe microgamete.
14.	Fertilization.
15, 16, 17.	The zygote.
18.	Beginning of spore formation.
19.	Completion of spore formation.
20.	Formation of the sporozoites within the spores.
21.	Release of the sporozoites in the intestine of the host.

Figure 2.

Introduced for comparison with the more typical cycle shown in figure 1. Here the parasite penetrates and comes to rest in the nucleus instead of the cytoplasm, and there is sexual differentiation in the schizogonous cycle as well as in sporogony.

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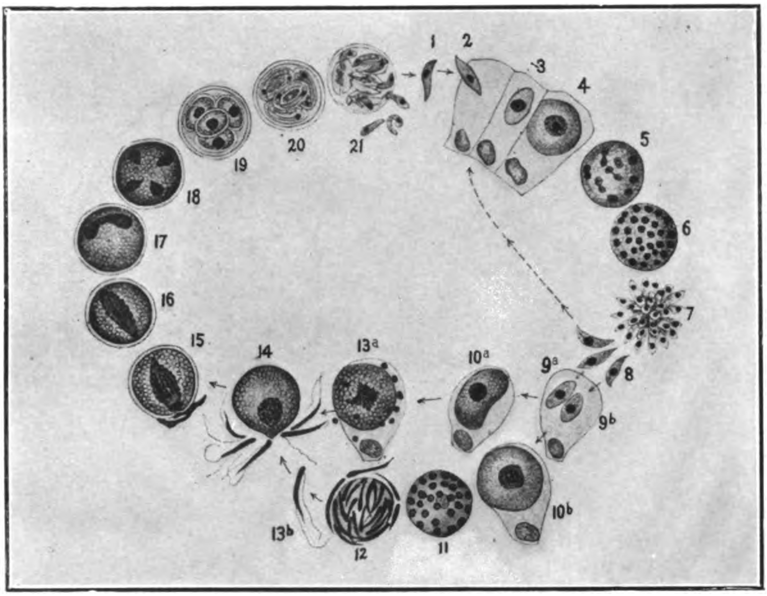

FIG. 1.

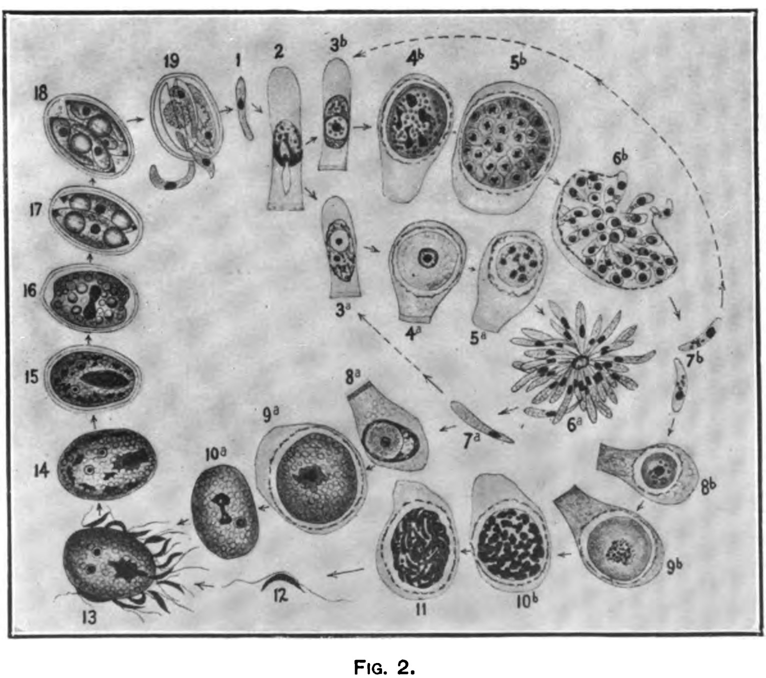

FIG. 2.

COCCIDIAN LIFE CYCLE. (FROM MENSE'S "HANDBUCH," AFTER SCHAUDINN.)

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is attacked, but Coccidia also invade the kidney, spleen, or testis. The life history of a coccidian is as follows (see Pl. XXXIX):

The encysted stage, or oocyst, is swallowed by some animal. Through the action of the digestive juices the sporozoites contained in the cyst are released in the lumen of the intestine. Each sporozoite then enters an epithelial cell of the mucous membrane lining the intestine. The sporozoite may then either settle down in this cell and proceed to grow, or else it may pass entirely through the intestinal wall, and eventually come to rest within a cell of the kidney or testicle. In either case, once established, the organism, now termed a trophozoite, grows until it reaches a certain definitive size, which is probably primarily dependent upon the size of the invaded cell. Then by a process termed schizogony the trophozoite divides into a number of small masses of protoplasm known as merozoites. These migrate to and enter other cells of the host, and then grow and divide in turn into another generation of merozoites. As a result of this schizogonous cycle, which may be repeated many times, a sufficient number of cells may be destroyed to cause the death of the host animal. Whether or not the host is killed, there finally comes a time when some of the merozoites, instead of growing and dividing into other merozoites, develop into sexual stages and thus begin the process known as sporogony. The male trophozoite divides into a number of very minute elements, known as microgametes. The female trophozoite does not divide, but develops into a macrogamete, or egg. The microgametes are motile, and like the spermatozoa of higher animals, seek out and fertilize the eggs. Immediately after fertilization the egg surrounds itself with a protective covering and becomes an oocyst. The oocysts reach the exterior with the feces of the host in the case of those species which are parasitic in cells of the alimentary tract or its appendages. Probably in some cases the oocysts reach the exterior only as a result of the host's death and disintegration. But, however this may be, the protoplasm forms within the cyst one or, by division, several spores, each of which becomes inclosed in a shell, the sporocyst. The protoplasm within the sporocyst then divides into two or more sporozoites, and the sporogonous cycle is complete. Upon the swallowing of the oocyst the processes described above are again repeated.

It will be noted from the account which has been given of the life history of the Coccidia that the number of parasites which may be produced as a result of infection does not necessarily depend upon the number of cysts swallowed, but upon the number of schizogonous generations, or repetitions of the schizogonous cycle. Were it not for the fact that sooner or later the process of reproduction by schizogony comes to an end, the host would invariably be killed by the extensive destruction of the cells of the organ or tissue attacked by the parasites. Since, however, the number of schizogonous generations is limited—by what agencies we are as yet unaware—the infected animal tends to recover if it survives the acute stage of the disease during which the parasites are multiplying by schizogony. With the inauguration of the sporogonous cycle the destruction of the cells of the host ceases, the acute symptoms subside, and meanwhile, through the recuperative powers of the affected tissues, new cells have taken the place of those destroyed by the parasites, so that the injury to the host is more or less completely repaired. Apparently,

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however, no immunity is produced, and another attack of the disease may result from a fresh infection from without.

Eimeria stiedæ.—This species, also known as *Coccidium oviforme*, causes a serious coccidiosis in rabbits, and though rare among wild rabbits, is a very common parasite of domesticated rabbits. It infests the epithelium of the bile ducts, causing, in addition to cellular destruction, enlargement of the liver and compression of its blood vessels. The secretion of bile is reduced, the blood becomes pale and watery, and the animal finally may become so profoundly affected that death results.

Forms similar to this species attack other small mammals, such as the mouse. Coccidiosis in man has been attributed to *Eimeria stiedæ* by some authors.

Coccidium zurni.—This coccidian is considered to be the cause of red diarrhea of cattle. The disease has been noted in Europe, where outbreaks of a similar character have also occurred among sheep. The lethality, however, for cattle seems to be rather low, varying from 2 to 4 per cent. As it is the intestinal cells which are attacked by the parasite, the mucosa of the intestine becomes stripped off in places, resulting in extensive hemorrhage into the lumen, which causes the red diarrhea. In fatal cases, death results within two days. Most of the recorded cases have occurred in Switzerland, in summer and autumn. Dampness favors the disease, probably for the reason that in dry weather the encysted infective stages of the parasite become desiccated, and thus many are killed.

Coccidia of birds.—Birds are very commonly infested with Coccidia. Investigations by this bureau[1] show that white diarrhea in chickens is caused by Coccidia and that intestinal coccidiosis of pigeons is also due to the same cause. Blackhead of turkeys has been ascribed by some investigators to a coccidian.

HÆMOSPORIDIA.

Like the Coccidia, the Hæmosporidia are cell parasites, but instead of being found in epithelial cells they occur in the cells of the blood, for the most part in the erythrocytes, or red corpuscles. The group contains some of the most dangerous parasites known, and is in this respect perhaps quite similar to the trypanosomes. In general, however, the diseases caused by Hæmosporidia do not have so high a rate of lethality as the trypanosomiases, but they attack a larger number of individuals. It is now a matter of common belief that one of the principal causes of the decadence of the ancient Greek and Roman civilizations was malaria, the most important hæmosporidian disease of man.

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[1] Morse, George Byron. White diarrhea of chicks. U. S. Department of Agriculture, Bureau of Animal Industry, Circular 128. 1908.

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The evident reason why the Hæmosporidia are more dangerous than the Coccidia is that they are not transmitted by contact or contamination, but by means of intermediate hosts. These, in the known cases, are mosquitoes, bugs, fleas, and ticks. The typical life history of the Hæmosporidia is as follows (see Pl. XL):

As in the case of the Coccidia, the hæmosporidian begins its career within its host as a sporozoite. Set free in the blood of the host, this sporozoite attacks and enters a blood cell, preferably an erythrocyte. Here it grows into a trophozoite, which is ameboid in one group of Hæmosporidia, the Acystosporea, and generally vermiform in another group, the Hæmosporea. The trophozoite, growing at the expense of the blood cell, soon breaks up into a number of merozoites. By the disintegration of the blood cell, the merozoites fall into the blood stream. Forthwith they attack new blood cells and the process (schizogony) is repeated. The increase is therefore by geometrical ratio, and, as Minchin says: "It is evident that reproduction at this rate could only continue indefinitely in the ichor of an infinite host." Accordingly, at the end of a certain number of generations, as in the Coccidia, schizogonous reproduction ceases and the parasite provides for its future by the production of male and female elements.

So far, the process is exactly parallel to that found in the Coccidia. In the Hæmosporidia, however, the male and female cells must be removed from the blood of the host to insure further development. This removal is effected by a blood-sucking arthropod, which takes the parasites into its alimentary canal. Here they mature, the male cells forming each a number of microgametes, the female cells each a single macrogamete or egg. The microgametes fertilize the macrogametes, which then metamorphose into elongated elements, the ookinetes. The ookinete pierces the intestinal epithelium of the mosquito and comes to rest in the periintestinal tissue. There is first a period of growth, during which the element assumes a spherical form and becomes inclosed by a delicate wall. This stage corresponds to the oocyst of the Coccidia, but no actual cyst is developed. Eventually the sporozoites are produced directly from this protoplasmic mass, the spore stage being omitted. Excepting for the fact that fertilization is postponed until after the removal of the parasite from the vertebrate host, that part of the acystosporean life history which is passed in the mosquito corresponds exactly to that part of the coccidian life history which is passed in the cyst.

The various species of Hæmosporidia are parasites of the blood of mammals, birds, reptiles, and batrachia. Minchin remarks as follows concerning the Hæmosporidia:

The effects produced * * * seem to differ markedly in the case of cold-blooded and warm-blooded animals. In the former, there is no evidence that these parasites, however numerous, produce any pathological effect upon their hosts at all, but in birds and mammals they cause fevers and agues of various kinds, of which those that trouble the human species are naturally the best known. At least three types of (malarial) fever are generally recognized, each caused by a distinct form of parasite—the two so-called benign intermittent fevers, tertian and quartan agues, and the pernicious estivo-autumnal fever or tropical malaria. In each case the parasite is introduced into the human body by the bite of a mosquito, and not, so far as is known, in any other way. After a period of incubation, varying from 6 to 12 days, according to the species of parasite, the fever makes its appearance. In the benign forms, the

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PLATE XL.—LIFE CYCLE OF THE MALARIA (HUMAN) PARASITE.

1.	Free sporozoite, either in salivary glands of the mosquito or in blood of man.
2.	Penetration of the sporozoite into a red blood cell.
3 to 6.	Growth of trophozoite.
7, 8.	Division of trophozoite which brings about destruction of the blood cell and the release of the merozoites in the blood stream. The free merozoites then enter new blood cells, and this cycle may be repeated many times. Finally, however, the sexual cycle is initiated as follows:
9a to 12a.	Growth and differentiation of female cell.
9b to 12b.	Growth and differentiation of male cell.
13a, 13b.	The male and female cells are swallowed by a mosquito.
14a.	Maturation of female cell.
14b.	Formation of microgametes.
15b.	Free microgamete.
16.	Fertilization.
17.	Ookinete.
18, 19, 20.	The ookinete attacks and penetrates a cell of the intestine of the mosquito, and passes completely through the epithelium, coming to rest in the peri-intestinal tissue. (There is not, in life, the reduction in size indicated by the figure.)
21 to 25.	Stages in the development of the cyst and formation of the sporozoites.
26.	Migration of the sporozoites.
27.	Sporozoites in the salivary glands of the mosquito.
13c to 17c.	These figures portray the cycle which is supposed to account for cases where malaria is latent, for a longer or shorter period. Ordinarily, unless removed by a mosquito, the differentiated male and female cells (12a and 12b) die, but under certain conditions the latter may continue to live in the blood, to give rise to a renewal of the disease.

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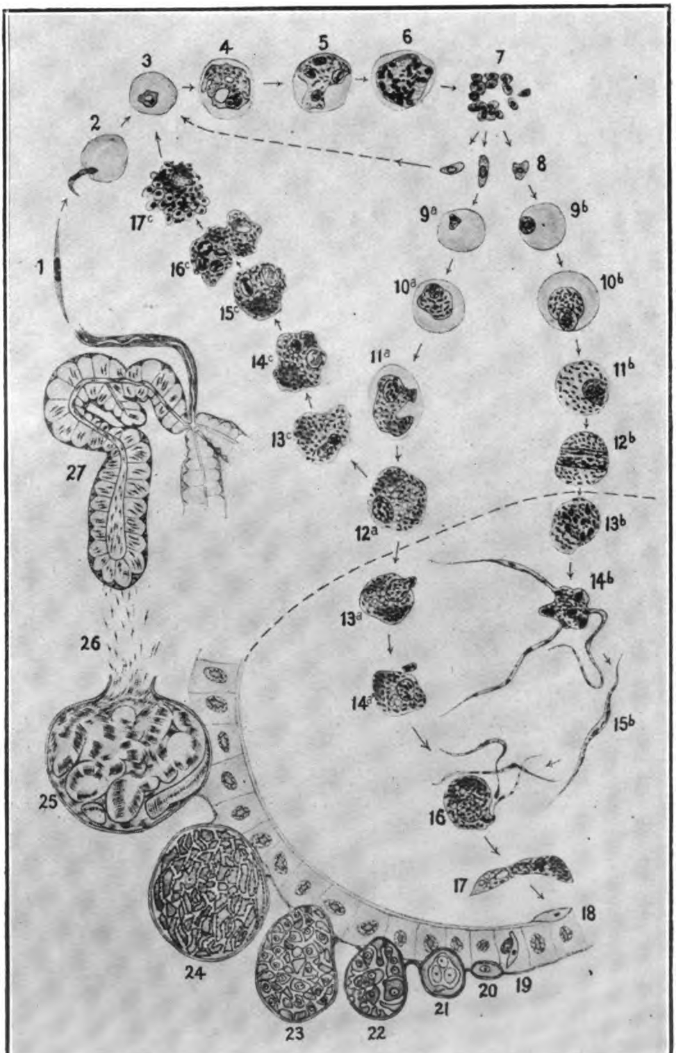

LIFE CYCLE OF THE MALARIA (HUMAN) PARASITE. (FROM MENSE'S "HANDBUCH," AFTER GRASSI AND SCHAUDINN.)

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feverish symptoms appear at regular intervals, dependent on the time occupied by a complete reproductive cycle of the parasite. Thus in the parasite of tertian ague the schizogony takes 48 hours, and the fever recurs every other day. In quartan ague the schizogony takes 72 hours, and the attacks of fever occur every three days. There may, however, be double or triple infections, the result of distinct inoculations; or again there may be mixed infections of the two forms, so that distinct generations of the parasites occur contemporaneously in a given patient, producing every possible variation in the frequency of the attacks of fever. In pernicious malaria, on the other hand, the sporulation takes place irregularly, and the fever is consequently irregular or continuous in its manifestations. In all cases the fever coincides in its appearance with the actual sporulation of the parasite, when vast numbers of the merozoites are set free in the blood and are attacking fresh, healthy corpuscles. The result of the rapid multiplication of the parasite in the blood, and the consequent destruction of the corpuscles, is a condition of anemia which tends to produce general cachexia, and may terminate fatally. At the same time the melanin granules produced by the parasite and dispersed in the blood when the sheltering corpuscle disintegrates and the merozoites scatter becomes deposited in the spleen and liver, which becomes hypertrophied, and also in the lungs, kidney, and brain, causing a pigmentation of these organs. In pernicious malaria death may ensue from the accumulation of the parasites in the brain to such an extent that the circulation is hindered or completely blocked.

Acystosporea.—In this group of Hæmosporidia, sometimes termed Plasmodidæ, the trophozoite remains in the blood cell which it entered as a sporozoite or merozoite until it divides to form another generation of merozoites, as already described in the account of the typical life cycle of the Hæmosporidia.

The parasites of human malaria are the most prominent members of the Acystosporea and belong to the genera *Plasmodium* and *Laverania*. *Proteosoma* is the form causing malaria in birds, a disease a good deal like that of man. So far as is known, none of the malarialike parasites attack any of the domesticated animals. In addition to the genera just mentioned, Doflein also includes in the Plasmodidæ, *Achromaticus*, a parasite of bats, and *Hæmocystidium*, a parasite of reptiles.

Hæmosporea.—The Hæmosporea, commonly known as hæmogregarines, differ from the Acystosporea principally in that the trophozoite, instead of remaining constantly within the blood cell which it originally attacks, may abandon the cell and live free in the blood plasma, later returning to another cell.

The hæmogregarines include the genera *Lankesterella* and *Karyolysus*, whose species are parasites of batrachia and reptiles, and the genus *Hæmogregarina*, the species of which parasitize all the groups of vertebrates. The carriers for this genus are leeches, ticks, lice, and fleas. It is more or less problematical whether this genus is pathogenic. The genus *Leucocytozoan* is morphologically a good deal like *Hæmogregarina*, but differs in that it selects white blood

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cells in which to live. Its members have only recently been brought to attention. They are parasites of mammals, birds, and batrachians. They seem to be quite pathogenic, but so far the work done on them has not been sufficient to determine their economic importance.

Two other genera of hæmosporidian parasites are generally put under the Acystosporea, although their affinities with this group are very doubtful. There is, however, no question as to their economic importance. These genera are *Piroplasma* and *Leishmania*.

PIROPLASMA.

PIROPLASMA BIGEMINUM.

Piroplasma bigeminum (fig. 74) is the agent of Texas fever. This disease occurs in North and South America, Cuba, Porto Rico, South Africa, the Philippines, and Australia. The carrier is the cattle tick (*Margaropus annulatus*), and the mode whereby the transfer is made is almost unique. The cattle tick, which seeks its host as a larva, never afterwards abandons it, but undergoes its metamorphoses and completes that part of its life history upon the animal ordinarily in the exact spot to which it first attached itself. Hence there is no opportunity for a given tick to transmit Texas fever. But by a remarkable adaptation this end is attained. During the last few days spent upon the animal, the female ticks, already fertilized, absorb an enormous amount of blood and become the so-called engorged females. As such they fall to the ground and some days later lay eggs, from which the next brood is hatched. In some unknown manner the parasites taken up with the blood get into the eggs, and hence are already present in the larval ticks when these are hatched. In other words, infection of the tick by the parasite is hereditary, and hereditary infection, in spite of a rather widespread impression to the contrary, is one of the rarest phenomena known.

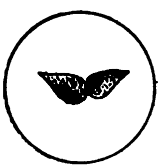

FIG. 74.—*Piroplasma bigeminum*. (After Doflein.)

It results from this mode of conveyance that Texas fever can be controlled much more readily than those diseases of which the carrier visits one host and then another, as, for instance, a fly. It is to be remembered, however, that a pasture in which ticky cattle harboring *Piroplasma* have been is not safe until all the ticks coming from these cattle, as well as the larvæ hatched from such eggs as they have laid, have died. This, in a warm region, may be a number of months.

The carriers of Texas fever in South America and Africa differ both from one another and from the species of the United States, but they are all very closely related, and the life history of each one is much the same.

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PIROPLASMA PARVUM.

Piroplasma parvum is the agent of Coast fever or Rhodesian fever. This is a virulent disease of cattle which occurs in Africa, Transcaucasia, and the Philippines. The carriers are the ticks *Rhipicephalus appendiculatus* and *R. simus*. Hereditary infection of these by the parasite has not been demonstrated, and it is not necessary, since these ticks abandon their hosts at the time of the metamorphoses and hence may carry the disease from one cow to another; that is, a tick which passes its larval stage on an infected animal may infect another animal upon which it passes its nymphal stage, and likewise a nymph grown on an infected animal may infect another animal upon which it lives as an adult.

PIROPLASMA OVIS.

Piroplasma ovis causes in sheep a disease known as carceag or ictero-hematuria. It has been described from Hungary, Germany, Roumania, the Balkan Peninsula, Italy, the West Indies, and South Africa. The tick *Rhipicephalus bursa* is the agent of transmission of carceag.

A disease resembling carceag occurs rather rarely among sheep in the western United States, but little is known concerning it or its agent of transmission.

PIROPLASMA EQUI.

Piroplasma equi causes biliary fever in horses. Its range is South Africa, Madagascar, and parts of Europe. The carrier is a tick, *Rhipicephalus evertsi.*

PIROPLASMA CANIS.

Piroplasma canis attacks dogs, the name given to the disease being malignant jaundice. It occurs in Europe, Africa, and India. It is carried by different ticks in different parts of its range; *Hæmophysalis leachi* in Africa, *Rhipicephalus sanguineus* in India, and *Dermacentor reticulatus* in Europe. Canine piroplasmosis probably exists in this country, but as yet satisfactory evidence of its occurrence has not been obtained.

GENERAL REMARKS ON PIROPLASMOSES.

Piroplasmoses are serious diseases, with a high death rate. Apparently all of them, however, may occur in two forms, the chronic and the acute. The former is well illustrated by Texas fever. As a result of the prevalence of the cattle tick in the Southern States nearly all southern cattle harbor the fever parasite in their blood, but do not suffer acutely, since, as already stated, they have undergone a sort of natural vaccination as young calves. But if infected ticks be placed on an adult cow from the Northern States, and the animal thus becomes inoculated with the *Piroplasma*, the chances are that she will die within a short time.

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PLATE XLI.—EVOLUTION OF THE PARASITE OF KALA-AZAR.

Figs. 1 to 5. Parasites of kala-azar.

1. Isolated parasites of different forms in the spleen and liver.
2. Division forms from liver and bone marrow.
3. Mononuclear spleen cells containing the parasites.
4. Groups of parasites.
5. Phagocytosis of a parasite by a polynuclear leucocyte.

Figs. 6 to 15. Parasites from cultures.

6. First changes in the parasites. The protoplasm has increased in bulk and the nucleus has become larger.
7. Further increase in size. Vacuolization of the protoplasm.
8. Division of the enlarged parasite.
9. Evolution of the flagella.
10. Small piriform parasite showing flagellum.
11. Further development and division of the parasite.
12. Flagellated trypanosome-like form.

13, 14. Flagellated forms dividing by a splitting-off of a portion of the protoplasm.

15. Narrow flagellated parasites which have arisen by the type of division shown in Figs. 13 and 14.

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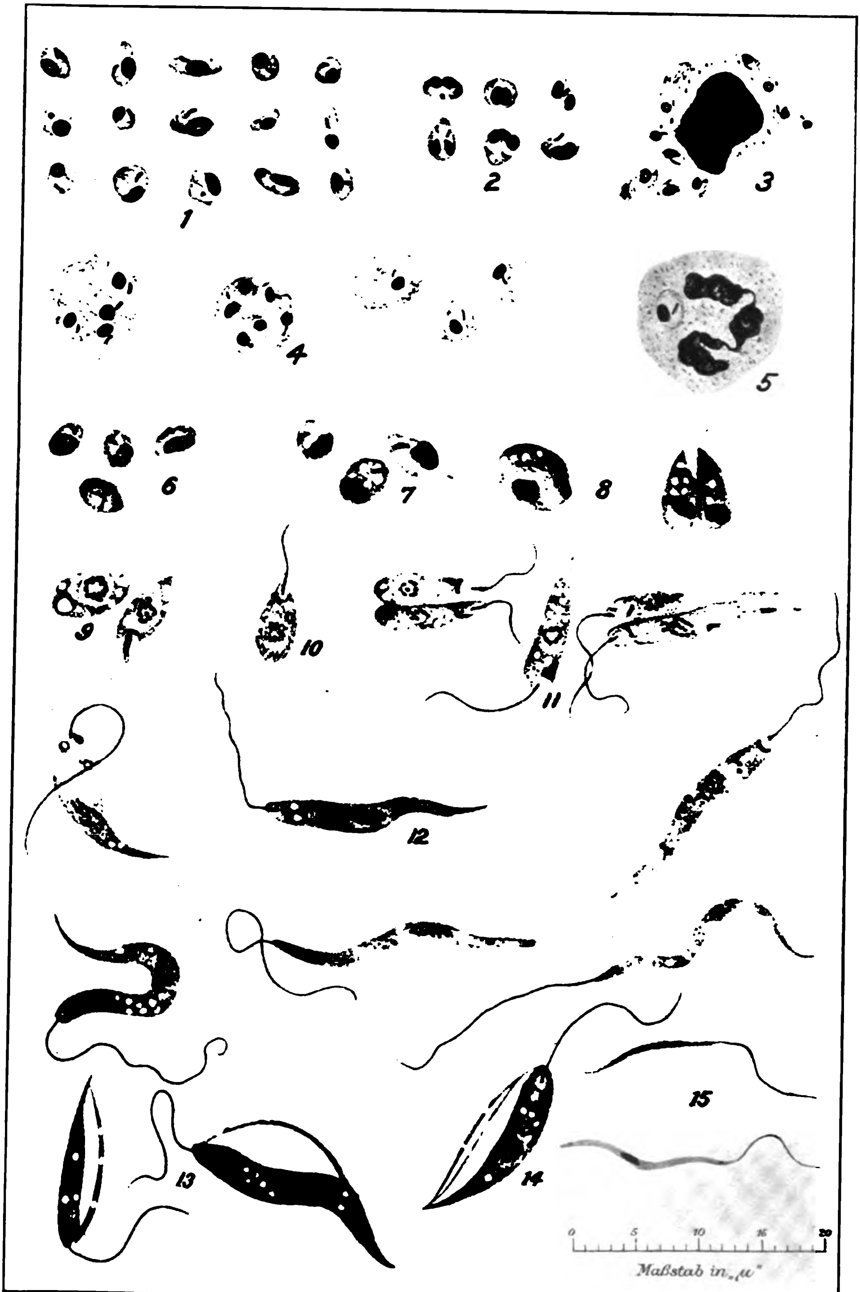

EVOLUTION OF THE PARASITE OF KALA-AZAR. (FROM MENSE'S "HANDBUCH," AFTER LEISHMAN.)

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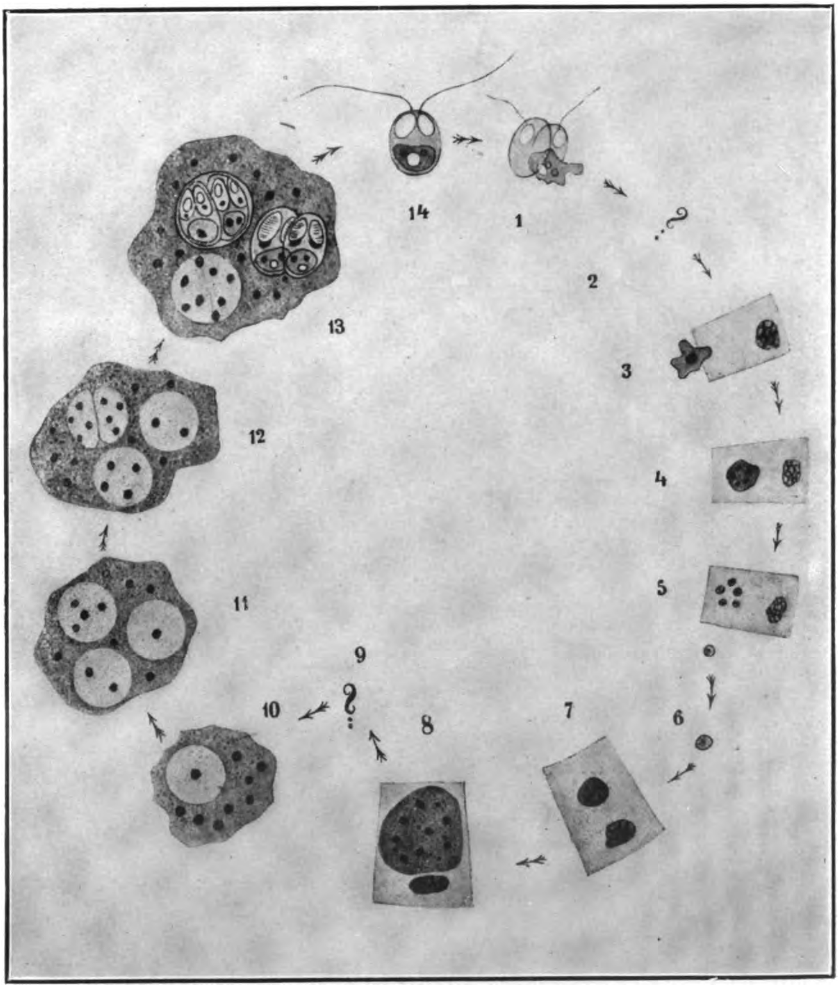

SCHEMATIC DEVELOPMENTAL CYCLE OF A MYXOSPORIDIAN. (FROM DOFLEIN.)

1. Spore opening spontaneously, from which the amebula is creeping. 2. Place where conjugation, if present, may occur. 3. Entrance of the amebula into an ephithelium cell. 4. Nuclear multiplication. 5. Multiple division. Each small body consists of a nucleus with a portion of the protoplasm of the mother cell. 6. Migration of the products of the division. 7, 8. Growth of these in a new cell. 9. Place where conjugation, if present, may occur. 10. Formation of sporoblasts, i. e., the elements from which the spores develop; one such shown. 11, 12. Further development of the sporoblasts; three shown. 13. Further development; two of the sporoblasts have become spores. 14. Ripe spore.

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Thus, in a region where piroplasmosis is present, the stock animals native to that region seldom suffer from the acute form of the disease. When, however, such animals are moved to a region where the disease does not exist, the disease tends to break out in the acute form amongst the susceptible animals of that region, causing heavy loss. It is the same when susceptible animals are taken into an infected region; they promptly acquire an acute form of the disease.

It is the last fact which stands in the way of the improvement of cattle in the Southern States. Unless first immunized, northern cattle can not safely be taken into the Southern States, and hence the advantage to be gained by the infusion of fresh blood into southern animals is lost.

LEISHMANIA.

In the genus *Leishmania* belongs the parasite of a tropical disease of man, known as kala-azar. It occurs endemic in many parts of Hindustan and in Burma, China, Arabia, Upper Egypt, Tunis, and Algeria. It has occurred as an epidemic in Assam. It is ordinarily fatal. (See Pl. XLI.)

The parasite of kala-azar is a minute rounded, oval, or pear-shaped organism, which is found generally throughout the body of the patient, but most abundantly in the liver, spleen, and bone marrow. It has a distinct cuticle. The cytoplasm is often vacuolated, and there are two nuclei. These bodies multiply either by simple fission or endogenous multiplication.

The most remarkable feature about these Leishman-Donovan bodies, however, is the fact that if placed in appropriate culture media they evolve into herpetomonads. That is, within the human body they are Sporozoa, much like piroplasms, whereas in culture tubes they become flagellates. Hence the exact zoological position of this parasite is a matter of considerable doubt, some authors placing it in the genus *Herpetomonas*, among the Mastegophora; others calling it *Leishmania* and considering it to be allied to *Piroplasma*.

The disease seems to be carried by the bedbug. Bedbugs fed on kala-azar patients later show in their intestines flagellated bodies resembling those found in the culture tubes.

NEOSPORIDIA.

This group of sporozoa is imperfectly known. Zoologically it is divided into three orders, the Sarcosporidia, Myxosporidia (see Pl. XLII), and Haplosporidia, only the first of which is represented among the parasites of domesticated animals. To Myxosporidia belong a number of forms which cause diseases very destructive to fishes. The parasite causing the disease of silkworms, known as pebrine, which has produced losses in the silkworm industry of France amounting to not less than $200,000,000, and a closely related para-

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site which causes malignant dysentery in bees, are both members of the order Myxosporidia. The Haplosporidia appear to be of comparatively little economic importance.

SARCOSPORIDIA.

Sarcosporidia are almost exclusively parasites of the striped muscles of mammals and birds. The trophozoite is elongated and inclosed in the early stages of its development by a delicate cuticle which later becomes an envelope of complicated structure. Spore formation begins at an early stage of development, and is carried on during the growth of the trophozoite. The spores, which are produced in enormous numbers, are very small banana-shaped or spindle-shaped bodies, each containing a nucleus. There may be a delicate cuticle, but, unlike the Coccidia, no protective shell is formed.

Sarcosporidia are common in domesticated mammals and are nearly always present in the pig and the sheep. They are also frequently present in the horse and the ox, and have been recorded from man. In birds they attack chickens and ducks, and have frequently been found in wild birds.

The earliest known stage of the parasite, known as a Miescher's tube, is shown in Plate XXXVII, figure 2. The muscles invaded are more usually those of the trunk in the vicinity of the alimentary canal; first those of the esophagus, then those of the larynx, the body wall, and the diaphragm, and the psoas muscles. In acute cases all skeletal muscles may be affected.

Within the muscle fiber the parasite grows until it distends the fiber to several times its normal breadth, and may finally rupture the fiber sheath and come to lie in the adjacent connective tissue. In this way the invaded muscles are more or less destroyed, necessarily to the injury of the host, and in addition it has been found that Sarcosporidia form a very poisonous toxin, which has been named sarcocystin by Laveran and Mesnil.

The mode whereby Sarcosporidia are transmitted from host to host is not known. It has been found that if mice be fed on the flesh of other mice containing Sarcosporidia they become infected after an incubation period of about six weeks. Since sarcosporidian infection is fatal to mice, and since mice nibble at or even completely devour their dead, this case presents no difficulty; but such a mode of transfer can not well be called into account for infections in cattle, horses, or sheep. The problem is one which requires further study.

The following members of the group may be considered:

SARCOCYSTIS MIESCHERIANA.

This species occurs in swine. The trophozoites may reach a length of 4 millimeters, with a breadth of 3 millimeters. Almost any

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muscle may be attacked. The earlier students credited this species with causing a serious although not fatal disease in swine, but it is doubtful if this is so. An extensive invasion of the muscles of the body and hind quarters would, however, render the flesh undesirable for food.

SARCOSCYSTIS BERTRAMI.

This form parasitizes the horse. The parasites reach a length of 9 to 10 millimeters. In heavy infections there is a rather extensive destruction of the muscles, and by some authors this parasite is said to be the cause of a disease of young horses.

In the Western States of America, also, certain ailments of horses have been credited to sarcosporidian infection.

FIG. 75.—*Sarcocystis blanchardi.* Cross section of the esophagus of a cow (natural size). *a, b, c, d,* and *e* are cysts in the outer muscular coat; *f, g,* and *h* are cysts in the inner muscular coat. (After Doflein.)

SARCOCYSTIS TENELLA.

This species (see Pl. XXXVII, figs. 3 and 4) is a parasite of the sheep, and may reach a length of one-half inch. In certain regions of Europe nearly all sheep are infected. Its usual situation is the muscles of the throat, but it may also be present in many other parts of the body, among which are the heart muscles. In Europe this form is credited with being quite pathogenic for sheep and frequently a cause of death.

SARCOCYSTIS BLANCHARDI.

This species was first observed in Java in the zebu, and is not uncommon in domesticated cattle throughout the world. It may occur in nearly any muscle, and it is said to be constantly present in the tongues of Sicilian cattle. (See fig. 75 and Pl. XXXVII, fig. 2.)

Sarcocystis lindemanni is the form which has occasionally been found in man.

In mice Sarcosporidia are by no means rare, and the infections are apparently always fatal. Heavily infected mice are sluggish and present a fat, puffy appearance, due to the distension of the muscles by the parasites. This is seen in Plate XXXVII, figure 5, which shows the extent to which the parasite may be present, nearly every muscle bundle being invaded, and it is indeed remarkable that muscles so completely invaded are able to perform their usual functions.

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Sarcosporidia have never been taken much into account in considering the diseases of domesticated animals, since they never cause epizootics and are apparently never fatal. In the last few years, however, it is beginning to be suspected tha httey are quite dangerous parasites. Thus, very recently the camels of northern Africa were found to be extensively parasitized and to be thereby greatly debilitated. The group is deserving of much more attention than it has hitherto received.

CILIATA.

This group of Protozoa is composed of a large number of species. nearly all of which are free-living. Ciliates are universally distributed, occurring wherever there is water. When water containing organic matter is exposed to the air for a few days it will be found to be swarming with ciliates.

Scarcely any of the ciliates are parasitic, and it is questionable whether any are harmful parasites, with the possible exception of certain forms which are ectoparasitic on fishes.

In the paunch of ruminants are found numerous species of ciliates, and these are almost constantly present in very great numbers. They appear to do no damage, and indeed the possibility is not excluded that their presence may be actually beneficial to their hosts through some favorable influence which they may have on the digestive processes.

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MISCELLANEOUS INFORMATION CONCERNING THE LIVE-STOCK INDUSTRY.

Compiled by John Roberts,
Of the Editorial Office, Bureau of Animal Industry.

THE LIVE-STOCK MARKET IN 1910.

It was hardly anticipated at the close of 1909 that the hog would again be the dominating factor in the live-stock situation of the year. After the pronounced scarcity and high prices in the latter part of 1909 it seemed probable that hog raisers would resume business under such pronouncedly favorable conditions as ruled at that period. Evidently, however, a large proportion of the breeding stock had been sent to the block, and so the supply during 1910 continued to be far below the demand. The year's total receipts at the various stock yards show, in consequence, a serious reduction as compared with the two previous years. Prices, of course, mounted higher than ever, and whereas in 1909 all records since the war were eclipsed, the high mark of 1910 outdistanced even the war-time records.

The receipts of hogs in Chicago during 1910 were, in round figures, 1,000,000 less than in 1909 and 2,500,000 less than in 1908. Last year's receipts at Kansas City were also 1,000,000 less than in 1909, and the shortage at the other packing centers brought the total deficit for the year to about three and one-quarter millions. The total receipts at 11 centers in 1908 were 27,826,000 head, the corresponding total in 1910 being 19,523,000, which is a decrease of 8,303,000, or 30 per cent, in two years.

Under these circumstances it was not surprising that hogs made unprecedentedly high prices during 1910. The first table below, showing the average prices brought by the various classes of live stock at Chicago, gives the average for hogs for the year as $8.90 per hundredweight. The high month was March, the average for which reached $10.55, and during this month occurred the highest quotations for hogs ever known in the history of the trade.

The hog deficit was somewhat offset by the increased receipts of sheep, the total supplies amounting to about 2,000,000 more than in 1909. In spite of this the prices for sheep ruled higher than in the year before. It will be seen by the table that the annual average for the past year—$5.25—equaled the previously highest on record, which was in 1907.

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Cattle supplies in 1910 were about the same as in the previous year, but values ruled higher. In fact, the quotations in the spring and early summer indicated an exceedingly high average for the year, but these abnormal prices fell off very perceptibly in the later months. However, the year's average for cattle was 45 cents a hundredweight higher than in 1909, and for calves 35 cents.

The following tables show the monthly and annual average and range of prices of the various classes of farm stock at Chicago for a series of years. Only the first and last tables give average prices, the others showing the high and low range. In the case of the latter it should be borne in mind that the mean between the high and low range does not necessarily give the true average.

Average prices, per hundredweight, of live stock at Chicago in 1910, by months, and annual average, 1898–1910.

[From the Chicago Daily Farmers and Drovers Journal.]

Month and year.	Cattle.			Hogs.	Sheep.	Lambs.
	Native steers.	Cows and heifers.	Range steers.			
January	$6.20	$4.25	....	$8.55	$5.55	$8.30
February	6.35	4.55	....	9.05	6.50	8.65
March	7.35	5.60	....	10.55	7.60	9.40
April	7.55	5.90	....	9.90	7.60	9.10
May	7.50	5.55	....	9.55	6.55	8.40
June	7.50	5.15	....	9.45	5.10	7.60
July	7.10	4.65	$5.60	8.75	4.20	7.10
August	6.85	4.20	5.50	8.35	4.20	6.70
September	6.80	4.00	5.45	8.90	4.25	6.80
October	6.60	3.95	5.35	8.50	3.95	6.65
November	6.20	3.85	5.25	7.60	3.70	6.25
December	6.00	3.90	4.95	7.65	3.90	6.10
Annual average:						
1910	6.80	4.60	5.40	8.90	5.25	7.55
1909	6.35	4.25	5.35	7.35	4.95	7.30
1908	6.10	4.10	4.85	5.70	4.65	6.35
1907	5.80	3.85	4.50	6.15	5.25	7.05
1906	5.30	3.70	4.40	6.25	5.20	6.85
1905	5.05	3.65	3.80	5.25	5.00	6.80
1904	4.95	3.55	3.65	5.15	4.25	5.60
1903	4.80	3.95	3.65	6.00	4.00	5.45
1902	6.20	4.70	4.95	6.80	4.20	5.50
1901	5.25	4.05	4.55	5.85	3.80	4.80
1900	5.15	4.05	4.35	5.05	4.55	5.90
1899	5.30	3.55	4.60	4.05	4.35	5.50
1898	4.65	3.40	4.20	3.85	4.25	5.35

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Range of prices, per hundredweight, of cattle at Chicago in 1910, by months, and annual range, 1898–1910.

[Compiled from report of Union Stock Yard & Transit Co.]

Month and year.	Native steers (1,500-1,800 pounds).	Native steers (1,200-1,500 pounds).	Poor to best cows and heifers.	Native stockers and feeders.	Texas and western steers.
January	$6.20-$8.40	$4.90-$8.10	$3.10-$6.50	$2.90-$5.80	$4.90-$6.00
February	6.50- 8.10	5.30- 8.00	3.25- 7.10	3.00- 6.00	4.10- 4.65
March	7.50- 8.75	5.80- 8.85	3.65- 7.85	3.25- 7.00	6.25- 6.85
April	7.75- 8.65	6.35- 8.50	4.00- 8.00	3.50- 7.10	6.75- 7.10
May	7.70- 8.75	6.40- 8.75	4.00- 7.45	4.25- 6.65	6.35- 7.75
June	7.35- 8.75	5.90- 8.85	3.85- 7.75	3.00- 6.50	4.10- 7.75
July	6.75- 8.60	5.25- 8.50	3.25- 7.30	3.00- 6.00	4.30- 7.00
August	7.25- 8.50	5.25- 8.40	3.25- 7.25	3.15- 6.15	4.00- 7.40
September	6.80- 8.50	5.25- 8.50	3.30- 7.25	3.15- 6.00	4.00- 7.35
October	6.60- 8.00	4.90- 7.90	3.05- 7.25	3.00- 6.00	4.25- 7.10
November	5.85- 7.75	4.85- 7.65	3.10- 6.50	3.00- 5.85	4.25- 6.25
December	5.65- 7.00	4.90- 7.35	3.00- 6.75	3.00- 5.90	3.90- 5.60
Annual range:					
1910	5.65- 8.75	4.85- 8.85	3.00- 8.00	2.90- 7.00	3.90- 7.75
1909	6.20- 9.50	4.90- 9.25	2.90- 7.50	2.50- 5.85	3.60- 7.60
1908	5.25- 8.40	4.00- 8.40	2.55- 7.50	2.00- 6.05	3.40- 7.50
1907	5.30- 8.00	3.95- 7.50	2.35- 6.25	2.00- 5.35	3.00- 6.75
1906	4.75- 7.45	3.90- 7.90	2.40- 6.60	1.75- 5.10	2.90- 6.35
1905	4.40- 6.80	3.00- 6.85	2.25- 6.80	1.50- 5.45	2.60- 5.25
1904	4.40- 7.65	3.35- 7.60	2.00- 7.50	1.50- 5.50	2.40- 5.65
1903	4.10- 6.75	3.35- 6.85	2.50- 5.50	1.50- 5.20	2.55- 5.10
1902	4.25- 9.00	3.60- 9.00	3.35- 8.25	1.90- 6.00	2.55- 7.65
1901	4.80- 9.00	3.60- 8.00	2.00- 8.00	1.65- 5.15	2.75- 5.75
1900	4.70- 7.50	3.90- 7.50	1.75- 6.00	2.10- 5.25	3.00- 5.90
1899	4.60- 8.25	4.00- 8.25	2.00- 6.85	2.50- 5.40	3.10- 6.75
1898	4.10- 6.25	3.80- 6.15	2.00- 5.40	2.50- 5.40	3.15- 5.40

Seventy-three carloads of fat "show" steers sold in the auction Thursday, December 1, 1910, at $6.75 to $13.50; only one load above $9.15. The general average price was $7.77 per 100 pounds, against the record average price of $11.44 in 1909 for 52 loads.

Range of prices, per hundredweight, of hogs at Chicago, in 1910, by months, and annual range, 1899–1910.

[Compiled from report of Union Stock Yard & Transit Co.]

Month and year.	Heavy packing (250-500 pounds).	Mixed packing (200-250 pounds).	Light bacon (150-200 pounds).
January	$7.95-$9.05	$7.90-$9.05	$7.75-$9.00
February	8.15-10.00	8.10- 9.90	8.05- 9.80
March	9.55-11.20	9.50-11.15	9.45-11.05
April	8.75-11.00	8.75-10.90	8.75-10.80
May	9.05- 9.80	9.05- 9.85	9.05- 9.80
June	8.75- 9.75	8.85- 9.80	9.10- 9.80
July	7.50- 9.40	7.85- 9.55	8.30- 9.60
August	7.25- 9.50	7.55- 9.70	8.20- 9.70
September	8.10- 9.80	8.25-10.07½	8.65-10.10
October	7.45- 9.35	7.80- 9.55	8.25- 9.65
November	6.55- 8.65	6.60- 8.70	6.50- 8.70
December	6.85- 8.10	6.90- 8.10	6.80- 8.05
Annual range:			
1910	6.55-11.20	6.60-11.15	6.50-11.05
1909	5.60- 8.75	5.50- 8.70	5.20- 8.60
1908	4.00- 7.50	4.00- 7.50	3.95- 7.40
1907	3.75- 7.25	3.70- 7.22½	3.70- 7.17½
1906	5.00- 7.00	4.95- 7.10	4.90- 7.00
1905	4.35- 6.40	4.25- 6.42½	4.10- 6.45
1904	4.10- 6.30	4.15- 6.37½	4.00- 6.30
1903	3.85- 7.87½	3.90- 7.80	3.90- 7.70
1902	5.70- 8.25	5.65- 8.20	5.40- 7.95
1901	4.80- 7.37½	4.85- 7.30	4.75- 7.20
1900	4.15- 5.85	4.15- 5.82½	4.10- 5.75
1899	3.35- 4.95	3.40- 5.00	3.30- 5.00

Average weight of hogs, 1910, 237 pounds. It is worthy of remark that this is 18 pounds higher than in 1909. Ten carloads of Interna-

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tional Exposition "show" hogs sold in the auction Thursday, December 1, 1910, at $7.50 to $7.75 per 100 pounds. In 1909 15 cars sold at an average of $8.60.

Range of prices, per hundredweight, of sheep and lambs at Chicago in 1910, by months, and annual range, 1899–1910.

[Compiled from report of Union Stock Yard & Transit Co.]

Month and year.	Native sheep (60–140 pounds).	Native yearlings and lambs.	Western sheep (70–140 pounds).	Western and Mexican lambs.
January	$3.25–$6.60	$5.60–$9.10	$3.25–$6.30	$7.00–$9.10
February	3.50– 7.50	5.50– 9.30	4.00– 7.90	6.50– 9.40
March	5.00– 9.00	6.35–10.25	5.00– 9.30	7.00–10.60
April	4.00– 8.50	5.50– 9.60	4.00– 8.40	6.00–10.20
May	3.50– 7.75	5.00– 9.00	4.25– 7.65	5.50– 9.40
June	2.50– 6.00	4.85– 8.60	3.75– 6.25	5.35– 9.10
July	2.00– 4.75	4.25– 8.60	2.50– 5.00	6.25– 8.00
August	2.00– 4.50	4.00– 7.15	3.00– 4.65	6.00– 7.15
September	2.50– 4.85	4.00– 7.40	3.00– 4.65	6.00– 7.30
October	2.00– 4.50	4.25– 7.20	2.75– 4.00	5.75– 7.00
November	2.00– 4.50	4.00– 6.90	2.00– 4.50	4.75– 6.75
December	2.50– 4.50	4.25– 6.80	2.85– 4.50	5.25– 6.80
Annual range:				
1910	2.00– 9.00	4.00–10.25	2.90– 9.30	4.75–10.60
1909	2.25– 6.90	4.50– 8.80	2.75– 6.85	5.00– 9.90
1908	2.00– 7.00	3.25– 7.85	2.00– 7.00	3.75– 8.35
1907	2.00– 7.00	4.00– 8.60	2.00– 7.25	4.00– 9.25
1906	3.00– 6.50	5.00– 8.50	3.00– 7.00	4.75–11.25
1905	2.75– 6.35	4.00– 8.25	3.15– 6.35	4.50– 8.20
1904	1.50– 6.00	2.50– 7.75	2.00– 5.80	3.00– 7.50
1903	1.25– 7.00	2.50– 8.00	2.00– 7.00	2.50– 7.90
1902	1.25– 6.50	2.00– 7.25	1.25– 6.30	2.50– 7.60
1901	1.40– 5.25	2.00– 6.25	1.50– 5.25	2.75– 5.90
1900	2.00– 6.50	3.00– 7.60	3.00– 6.50	4.00– 7.60
1899	2.25– 5.65	3.50– 7.45	2.50– 5.55	4.00– 7.00

Thirty-four carloads of "show" sheep and lambs sold Thursday, December 1, 1910, at a range of $4.50 to $10.25, the general average being $6.59 for the 34 loads, against $8.67 a year ago for 19 loads. Twenty-three loads of lambs sold at $5.50 to $10.25, the average being $7.19. Five loads of yearlings, at $4.85 to $5.75, averaged $5.39, and 6 loads of sheep, at $4.50 to $6, averaged $5.31.

Average prices of horses at Chicago in 1910, by months, and annual average, 1904–1910.

[Compiled from report of Union Stock Yard & Transit Co.]

Month and year.	Draft horses.	Carriage pairs.	Drivers.	General use.	Bussers and trammers.	Saddlers.	Southern chunks.
January	$195.00	$450.00	$170.00	$145.00	$155.00	$175.00	$85.00
February	205.00	500.00	175.00	150.00	165.00	185.00	90.00
March	210.00	520.00	180.00	155.00	170.00	190.00	95.00
April	210.00	520.00	180.00	155.00	170.00	190.00	95.00
May	205.00	510.00	175.00	150.00	165.00	185.00	90.00
June	200.00	500.00	170.00	145.00	155.00	175.00	85.00
July	200.00	475.00	170.00	145.00	155.00	175.00	80.00
August	200.00	450.00	170.00	140.00	155.00	170.00	75.00
September	200.00	450.00	170.00	140.00	155.00	175.00	75.00
October	195.00	450.00	170.00	140.00	160.00	175.00	85.00
November	190.00	425.00	170.00	135.00	160.00	170.00	90.00
December	190.00	425.00	170.00	135.00	155.00	170.00	95.00
Annual average:							
1910	200.00	473.00	172.00	144.00	161.00	177.00	87.00
1909	194.00	482.00	165.00	137.00	152.00	172.00	77.00
1908	180.00	450.00	156.00	129.00	138.00	164.00	69.00
1907	194.00	482.00	165.00	137.00	152.00	172.00	77.50
1906	188.00	486.00	158.00	154.00	147.00	174.00	72.50
1905	186.00	486.00	156.00	132.00	145.00	172.00	70.00
1904	177.00	475.00	150.00	140.00	140.00	160.00	64.00

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HOME AND FOREIGN MEAT PRICES.

In view of the high prices of meat in recent years, it is of interest to note how the prices in the United States compare with those in the principal meat-consuming countries of Europe. To this end a comparison is made in the following tables of the prices of the several kinds of fresh meat—beef, veal, mutton, lamb, and pork—at the five largest American and European cities. The prices are wholesale, not retail, and are usually for carcass lots.

In order that the comparison may be as nearly accurate as possible, a representative high grade of each class of meat has been selected, the aim being to have each class as nearly similar in grade as practicable. The markets represented in the tables are Chicago, New York, London, Berlin, and Paris. The prices quoted are from well-known trade papers and are shown at monthly intervals. The data for the European cities have been converted at the standard rates into the United States equivalents in pounds and cents.

BEEF.

The table below shows that the wholesale prices of beef in Chicago during 1910 were uniformly higher than those of the two previous years, excepting the last three months. The highest prices of the year—12½ cents a pound—occurred in April and May.

New York quotations generally followed those of Chicago, although in a number of instances they were slightly lower.

The London prices show that there is practically no difference on that market between English beef and port-killed American beef, which speaks well for the quality of our export steers. The table shows also that the margin between the Chicago and London figures is so small nowadays that there is little or no profit in exporting. Hence this portion of our trade, formerly of great magnitude, has been rapidly declining in recent years.

Good beef commands a high price in Berlin. The quotations at the German capital are usually several cents higher than any others in the table. The highest prices in 1910 ruled in the late summer and early fall, the top notch, 19 cents a pound, being touched in September.

Beef in the Paris market was somewhat cheaper during the first half of 1910 than it was in the same period of 1909, but prices advanced in July and August. The quotations for these months, the highest of the year, reached 16.32 cents a pound. It may be noticed, however, that the Parisian prices are for hind quarters, which are usually rated about 1½ cents higher than the price for the whole side. With this deduction from the French prices it is seen that the best grades are in most instances not much higher than those of London.

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Wholesale prices, per pound, of fresh beef at stated home and foreign markets, 1908 to 1910, at monthly periods.

Dates.	Chicago.	New York.	London.		Berlin.	Paris.
	Good native steers, carcass.	Choice native steers, heavy carcass.	English beef.	American (London killed).	Fat oxen.	Hind quarters.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January..........1910..	10.50-12.00	10.50-11.00	11.70-12.70	11.20-12.40	16.20-17.30	7.02-14.57
1909..	10.50-11.50	10.75	12.17-12.68	11.65-13.18	15.97-16.62	9.65-15.79
1908..	9.25	9.75	11.00-11.25	10.25-11.75	17.75-18.38	8.77-14.04
February.........1910..	10.00-11.50	10.00-10.50	11.70-12.20	11.70-12.40	15.50-16.40	7.02-13.16
1909..	10.50-11.50	10.00	10.65-10.90	10.65-11.65	15.33-15.97	9.65-14.04
1908..	9.75	9.25	10.75-11.25	10.50-11.00	16.63-17.25	7.90-13.16
March............1910..	10.00-11.50	11.00-11.50	11.70-12.20	11.90-12.40	15.50-16.40	8.77-14.04
1909..	10.00-10.50	10.00	11.40-12.17	11.65-12.17	14.90-15.76	8.77-14.57
1908..	9.50	9.00	10.50-10.75	10.25-11.00	15.75-16.38	7.90-13.70
April............1910..	12.00-12.50	12.00-12.50	11.90-12.70	12.20-13.00	16.20-17.30	8.77-14.04
1909..	10.00-11.00	10.25	11.40-12.42	11.65-12.42	15.11-15.76	8.77-15.44
1908..	10.00	11.50	11.00-11.50	10.75-11.50	15.50-16.25	7.90-14.04
May..............1910..	12.00-12.50	12.00	12.20-13.00	12.20-13.20	16.40-17.70	9.65-15.44
1909..	10.50-11.00	10.00	11.65-12.17	11.65-12.17	14.90-15.97	10.53-16.67
1908..	11.00-12.50	11.75	10.75-11.00	10.75-11.25	15.50-16.25	7.90-14.04
June.............1910..	11.00-12.00	11.75	12.70-14.00	12.20-13.70	17.10-17.70	9.65-15.44
1909..	11.00	10.00-10.50	11.65-12.42	11.40-12.42	14.68-16.19	10.53-16.67
1908..	10.00-10.50	11.25	12.50-12.75	12.25-12.75	14.90-15.75	8.77-16.67
July.............1910..	11.50-12.00	12.00-12.50	12.40-13.20	12.20-13.20	17.70-18.10	8.77-16.32
1909..	10.50	9.75-10.50	12.93-13.69	12.68-13.69	15.11-16.41	8.77-15.79
1908..	11.50-12.00	12.00	11.50-12.25	11.50-12.50	15.75-16.90	9.65-16.67
August...........1910..	11.00-12.00	11.50-12.00	12.70-13.70	12.20-13.70	17.90-18.60	9.65-16.32
1909..	10.50	9.75-10.50	11.40-11.91	12.17-12.68	15.76-16.84	7.02-14.91
1908..	10.50-11.00	11.00	11.25-12.25	11.50-12.75	16.63-17.75	9.65-15.79
September........1910..	11.50-12.00	11.50-12.00	12.20-13.20	11.20-13.20	18.10-19.00	10.53-14.91
1909..	11.00	9.75-11.00	11.65-12.68	11.65-12.68	16.19-17.27	8.77-14.91
1908..	10.00-11.00	10.75	10.75-11.25	10.75-12.25	17.00-18.13	10.53-15.79
October..........1910..	11.50-12.00	12.00	10.70-11.40	11.70-12.70	17.70-18.60	8.77-14.04
1909..	11.50-12.00	11.00-11.50	11.15-11.65	11.15-11.65	15.97-17.05	7.02-14.91
1908..	10.50-11.50	10.75	10.50-11.25	10.00-11.25	17.00-17.90	8.77-14.91
November.........1910..	11.25-11.75	11.00-11.50	11.00-12.40	11.20-12.40	17.90-18.80	10.53-14.57
1909..	11.50-12.00	11.00-12.00	10.65-11.91	10.65-11.91	16.41-17.70	7.02-13.69
1908..	10.50-11.00	10.50	10.25-11.75	10.25-11.25	16.37-17.25	7.90-14.04
December.........1910..	11.25-11.75	10.00-10.50	10.70-11.70	10.20-11.70	16.60-17.50	8.77-13.70
1909..	11.00-12.00	11.00-11.50	10.90-12.17	10.65-12.17	16.19-17.50	7.90-13.16
1908..	10.50-11.00	10.75	11.50-12.25	10.00-11.25	15.75-16.63	8.77-14.57

VEAL.

The price of veal at Chicago and New York during 1910 was noticeably higher than in the two previous years, although the stock-yards reports show that the supply was about 5 per cent greater than in 1909. It may be noticed that there is a considerable difference in price between the "prime, city dressed" veal of New York and the highest market class in Chicago, which is described as "good carcass." The table shows the New York quotation to be in many instances as much as 3 cents a pound higher than Chicago.

By far the highest values for veal are seen in the Berlin column. This grade, however, is without doubt a very choice article. It is described as "choice whole-milk fed." It will be seen that on several occasions the price reached as high as 28 cents a pound. The best cuts, when sold at retail, must therefore have brought a price that could only have been within the reach of the wealthy.

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Wholesale prices, per pound, of fresh carcass veal at stated home and foreign markets, 1908 to 1910, at monthly periods.

Dates.		Chicago.	New York.	London.	Berlin.	Paris.
		Good carcass.	Prime, city dressed.	Best veal.	Choice whole-milk fed.	Extra.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	1910	13.00	12.00-15.50	15.70-17.20	28.30	17.55-19.30
	1909	12.00	15.00-16.00	12.68-14.20	20.71-22.03	19.83-21.05
	1908	11.00	14.00-14.50	16.00-16.88	20.50-22.03	19.30-21.05
February	1910	13.50	13.50-16.50	14.20-16.20	27.70	18.08-19.30
	1909	11.00	14.00-15.00	13.69-15.21	19.21-20.50	18.08-19.30
	1908	11.00	14.00-14.50	13.69-15.21	19.00-20.06	18.08-19.30
March	1910	14.00	13.50-16.50	14.70-16.20	28.50	17.20-18.43
	1909	12.00	15.00-16.00	13.69-15.21	18.98-19.85	18.08-18.43
	1908	11.00	14.00	14.20-16.00	17.75-18.50	17.50-19.00
April	1910	13.50	13.50-16.00	14.70-16.20	23.00-27.40	18.43-20.18
	1909	12.00	13.50-14.50	14.20-15.72	18.77-19.85	18.08-19.30
	1908	11.00	13.00	15.21-16.00	18.60-19.50	16.67-18.43
May	1910	13.00	13.50	13.70-15.20	24.00-27.40	18.96-20.18
	1909	11.50	11.00-12.50	13.18-14.20	20.06-20.93	18.96-20.18
	1908	10.50	12.00	13.00-13.72	19.50-20.21	16.30-17.30
June	1910	13.00	13.50-14.50	13.20-15.20	21.60-25.90	14.91-16.67
	1909	11.00	12.00-13.50	14.70-15.72	20.27-21.36	16.67-18.08
	1908	10.00	11.00	13.70-15.20	19.00-20.21	18.30-19.79
July	1910	13.00	14.00-14.50	13.70-15.20	20.90-25.30	14.91-15.79
	1909	12.00	11.00-13.00	12.68-14.20	19.21-20.06	14.04-14.91
	1908	10.50	11.00-12.00	13.69-15.20	19.00-20.06	16.67-17.43
August	1910	13.50	15.50	14.20-16.20	21.10-25.10	17.55-18.43
	1909	12.50	12.00-14.00	11.15-12.17	22.46-24.84	12.28-13.16
	1908	11.00	12.00-13.00	13.00-13.72	19.85-21.06	16.30-17.30
September	1910	13.50	16.50	15.70-17.20	22.70-25.50	18.96-20.18
	1909	13.00	12.50-15.00	12.68-14.20	23.54	16.32-17.20
	1908	11.50	14.00-14.50	15.21-16.00	19.56-20.70	18.30-19.20
October	1910	14.00	16.50-17.00	14.70-15.20	22.70-27.00	17.20-18.43
	1909	13.50	12.50-15.50	12.17-13.18	23.11	15.79-17.20
	1908	12.00	14.00-15.00	14.21-15.69	19.55-20.70	17.43-19.05
November	1910	14.50	16.50-17.00	15.20-16.20	22.70-28.10	18.43-19.30
	1909	12.50	12.00-15.00	13.18-14.20	25.92	16.67-18.08
	1908	11.50	14.00	13.00-13.72	20.70-21.62	17.43-19.05
December	1910	14.00	16.50-17.00	15.20-16.20	24.20-28.10	16.67-18.43
	1909	12.00	12.00-15.50	15.21-16.22	26.56	16.67-18.43
	1908	10.50	14.00-15.00	13.38-15.20	19.85-21.06	17.20-18.43

MUTTON.

Mutton commanded an extraordinarily high price in Chicago during the spring months of 1910. The table shows that the top mark was in May, when the price was 16½ cents a pound, as against only 10½ cents for the same time in 1909. Heavy marketings of sheep later in the year brought the price down to 12 cents.

It is rather singular that New York mutton prices were generally lower than those at Chicago throughout the year. In some instances the difference was as much as 3 and 4 cents a pound.

London and Berlin mutton was also uniformly higher. Paris prices, on the contrary, ruled lower than in 1909. The Parisian quotations for mutton are the highest in the table. They are sometimes 100 per cent higher than the American prices. Good mutton is, in fact, a highly esteemed meat among the French. A comparison with the succeeding table for lamb shows that the latter usually brings a lower price than mutton. The reverse is the case at all the other markets quoted in the tables.

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Wholesale prices, per pound, of fresh carcass mutton at stated home and foreign markets, 1908 to 1910, at monthly periods.

Dates.		Chicago.	New York.	London.	Berlin.	Paris.
		Good sheep.	Choice sheep.	English.	Fat wethers.	First quality.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	1910	10.00	9.00–10.00	10.20–12.20	15.80–16.60	17.55–18.96
	1909	9.50	9.00	11.15–13.18	14.03–14.90	18.95–20.18
	1908	10.00	10.00	13.00–14.50	15.75–16.38	18.38–20.12
February	1910	10.00	9.50–11.00	11.20–12.70	14.70–15.80	17.55–18.43
	1909	10.50	9.50	9.63–10.65	13.17–14.03	17.20–18.43
	1908	10.50	10.00–10.50	13.00–15.25	14.88–15.50	18.38–19.25
March	1910	14.00	11.50–13.00	13.70–14.70	14.90–16.40	17.55–18.96
	1909	10.50	8.50– 9.50	10.13–12.17	13.60–14.03	17.55–18.43
	1908	10.50	11.25	13.00–15.25	14.00–14.75	18.38–19.75
April	1910	16.00	15.00–15.50	13.70–15.20	14.50–16.00	18.43–19.83
	1909	10.50	10.00–11.50	11.15–12.68	13.39–13.82	18.43–19.83
	1908	13.00	14.00	13.38–15.25	14.12–14.82	18.38–20.12
May	1910	16.50	15.00–15.50	12.70–14.70	15.10–16.60	18.43–19.30
	1909	10.50	10.00–11.00	13.18–14.70	14.25–14.68	18.43–19.30
	1908	12.00	13.00	12.25–13.75	14.12–14.88	16.62–17.50
June	1910	14.00	10.00–11.00	13.20–15.20	16.40–17.90	16.67–18.08
	1909	13.50	11.50–13.00	12.68–15.20	15.33–15.76	19.30–20.71
	1908	10.50	11.00	13.00–15.62	14.88–15.50	18.38–19.25
July	1910	13.50	10.00–11.00	12.70–14.20	16.00–17.70	17.55–18.96
	1909	11.50	10.00–11.00	11.65–14.20	15.76–16.19	19.30–21.93
	1908	9.50	10.00	13.00–14.25	14.88–15.50	18.38–19.75
August	1910	12.50	10.00–11.00	12.70–14.70	16.20–17.90	18.96–19.83
	1909	10.50	10.00–11.00	11.15–12.17	16.41–16.84	18.43–19.30
	1908	9.50–10.00	10.00	13.00–15.25	16.00–16.88	18.00–19.30
September	1910	12.50	10.00	11.70–14.20	16.40–17.90	17.55–18.96
	1909	11.00	8.50– 9.50	11.15–12.68	16.63–16.84	17.55–19.30
	1908	9.50	9.50	12.25–13.75	15.50–16.25	18.38–19.30
October	1910	12.50	9.00	11.20–12.20	14.90–16.20	15.79–18.08
	1909	9.50	8.50– 9.50	11.15–12.68	15.54–16.62	17.55–18.43
	1908	8.50	9.00	10.75–13.00	15.54–16.25	18.38–19.25
November	1910	12.00	8.50	11.20–13.70	15.80–16.80	17.55–18.96
	1909	9.50	8.00– 9.00	9.12–11.15	15.54–16.62	17.20–18.43
	1908	9.00	8.50– 9.00	11.25–13.00	14.25–15.50	17.50–19.00
December	1910	12.00	8.00	10.70–12.70	13.00–15.10	15.79–17.55
	1909	9.50	8.00– 9.00	9.63–11.65	15.97–17.05	16.67–18.08
	1908	9.50	9.00	10.75–13.00	14.12–15.12	17.25–18.38

LAMB.

As compared with 1908 and 1909 the prices of lamb at Chicago and New York in 1910 were exceptionally high, although somewhat erratic. The May quotation at Chicago was 4 cents higher than in 1909, and in most of the other months the price was well above the previous year, but in July and December the figures for 1910 were lower than those of 1909. In most instances the price at New York was lower than at Chicago, which, as has been stated, was also the case with mutton. However, it may be noted that the quotation for June was low at Chicago and high at New York.

The new season's lamb in England commands very high prices, compared with the other classes of British meat. The highest figures are recorded in March and April.

Choice lamb brings a high price in Berlin and Paris throughout the year. It may be noticed that the season of highest prices at the German capital is during the summer months.

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Wholesale prices, per pound, of fresh carcass lamb at stated home and foreign markets, 1908 to 1910, at monthly periods.

Dates.		Chicago.	New York.	London.	Berlin.	Paris.
		Round-dressed lambs.	Choice spring lambs.	Choice native.	Fat lambs.	Lambs, without head.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	1910..	15.00	12.00–14.00	17.20–19.20	17.90–18.60	12.28–18.43
	1909..	12.50	12.00–13.50	20.28–22.30	15.76–16.19	15.79–21.93
	1908..	13.00	12.50	19.86–22.84	18.10–18.50	17.50–21.85
February	1910..	14.50	12.00–14.50	17.20–19.20	16.40–17.50	13.16–17.55
	1909..	14.00	11.50–12.50	17.20–19.26	14.03–14.46	15.79–19.30
	1908..	13.50	12.50–13.00	19.00–21.26	17.00–17.25	14.85–18.36
March	1910..	15.00	13.00–16.00	22.30–24.30	16.60–17.50	10.53–21.93
	1909..	14.00	11.50–13.00	19.26–22.30	14.25–14.68	15.79–19.30
	1908..	13.00	13.00	19.86–24.25	16.25–16.50	14.86–19.30
April	1910..	17.50	17.00–18.00	18.20–23.30	16.20–17.10	14.04–19.30
	1909..	14.00	12.50–14.00	19.26–22.30	14.03–14.25	15.79–20.18
	1908..	15.50	15.50	19.86–22.86	16.34–16.75	14.00–19.25
May	1910..	17.50	17.50	16.20–20.30	16.60–17.70	12.28–18.43
	1909..	13.50	13.00–14.50	19.26–22.30	14.90–15.11	15.79–20.18
	1908..	14.50	15.00	19.00–22.15	16.34–16.75	14.00–17.50
June	1910..	15.50	17.00–18.00	15.20–18.20	18.60–19.00	8.77–17.55
	1909..	16.00	15.00–17.00	16.22–20.28	15.97–16.19	15.79–21.05
	1908..	12.50	15.00–16.00	16.86–21.20	16.75–17.25	15.79–21.05
July	1910..	15.50	14.50	14.20–17.20	17.90–18.60	13.16–18.96
	1909..	16.00	12.50–15.50	14.20–16.22	16.41–16.63	15.79–21.05
	1908..	12.50	12.50	16.00–19.00	16.75–17.25	14.00–19.75
August	1910..	14.50	14.00–14.50	14.20–16.20	18.40–19.00	10.53–19.30
	1909..	14.50	10.00–13.00	12.17–12.42	17.05–17.49	15.79–20.18
	1908..	12.50	11.50–12.00	15.20–18.20	17.70–17.91	15.79–20.18
September	1910..	14.00	13.50	14.20–16.20	18.40–19.00	12.28–18.96
	1909..	14.00	11.00–13.50	12.17–14.20	17.27–17.91	15.79–20.18
	1908..	12.00	12.00	13.38–14.20	16.70–17.30	14.85–20.87
October	1910..	14.50	13.50	13.20–14.20	16.80–17.30	10.53–17.55
	1909..	13.00	11.00–13.00	11.15–13.18	17.27–17.70	15.79–21.05
	1908..	11.00	11.00	13.00–13.75	16.80–17.30	14.85–21.05
November	1910..	13.25	12.00	12.20–13.20	16.80–17.90	10.53–20.18
	1909..	12.00	10.00–12.00	10.13–12.17	17.27–17.70	15.79–21.05
	1908..	11.50	12.00	10.75–13.00	16.36–16.88	14.84–23.36
December	1910..	11.50	12.00	12.20–13.70	15.80–17.50	10.53–19.30
	1909..	13.00	11.00–13.00	10.13–12.17	18.14–18.56	15.79–21.05
	1908..	12.00	12.00	12.20–13.00	16.00–16.40	15.79–21.05

PORK.

Dressed pork reached higher prices at Chicago in the spring of 1910, and also in the fall, than were ever before recorded. The table shows the high mark of 14 cents a pound to have been reached in the months of April, September, and October. The New York figures were generally a shade lower than those for Chicago throughout the year, the two highest months being June and October, when 13⅝ cents was touched.

The London quotations indicate that pig meat was scarce and high in England also. Excepting the last four months of the year the prices average about 2 cents a pound higher than in 1909, which is equivalent to 15 per cent.

The high prices of pork in Berlin in the later months of 1909 were not sustained last year, and it may be noted that in most instances the figures were lower than those of London. A reference to the other tables shows, however, that pork is the only comparatively cheap meat at the German capital.

Pork was very cheap at Paris in the early months of 1910, the prices being about parallel with those of New York. Later the

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quotations rose rather sharply and for the rest of the year closely approximated those of Berlin and London.

Wholesale prices, per pound, of fresh carcass pork at stated home and foreign markets, 1908 to 1910, at monthly periods.

Dates.		Chicago.	New York.	London.	Berlin.	Paris.
		Dressed hogs.	Dressed hogs.	Best (small and medium).	Choice (medium weight).	Extra.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	1910	11.00-11.50	12.25	14.70-15.21	15.76-16.07	11.40-12.28
	1909	7.50- 8.50	8.25	11.65-12.17	15.11-15.33	13.16-14.91
	1908	9.50- 9.75	7.13	11.25-12.50	12.75	14.88-16.12
February	1910	11.25-11.75	12.00	14.70-15.21	14.76-15.11	11.40-12.11
	1909	7.50- 8.50	8.88	11.65-12.68	14.90-15.11	12.28-13.16
	1908	9.50- 9.75	6.63	12.25-13.00	12.13	15.50-16.25
March	1910	12.50-13.50	12.38	14.20-14.70	14.76-15.11	11.75-12.63
	1909	7.50- 8.50	9.12	13.69-14.20	14.25-14.46	12.28-13.16
	1908	6.25- 6.75	6.75	11.25-12.50	11.75	14.50-16.63
April	1910	13.50-14.00	12.62	15.21-16.24	15.25-15.54	12.98-14.04
	1909	8.50- 9.50	9.50	13.69-14.20	14.03	11.93-12.81
	1908	6.75- 7.25	8.50	12.25-13.00	11.75	14.86-15.75
May	1910	13.00-13.50	13.50	14.70-15.72	14.76	14.04-14.91
	1909	9.50-10.00	10.00	12.17-13.18	13.17-13.39	12.28-13.16
	1908	7.50- 8.00	8.75	10.75-12.25	12.13	14.00-14.87
June	1910	12.00-12.50	13.63	14.70-15.72	13.60-13.84	14.04-15.26
	1909	9.50-10.00	10.25	13.69-14.70	13.60	12.28-13.16
	1908	7.00- 7.50	7.87- 8.00	10.25-11.25	12.50	15.50-16.25
July	1910	12.50-13.50	13.50	14.70-15.21	13.60-13.84	14.91-15.79
	1909	10.00-10.75	11.00	12.68-13.18	14.03-14.25	12.28-13.16
	1908	8.50- 9.00	9.13- 9.25	10.25-11.25	12.75	14.87-15.75
August	1910	13.00-13.75	13.00	15.21-15.72	14.25-14.54	14.91-15.79
	1909	10.75-11.25	11.25	12.17-12.68	15.54-15.76	13.51-14.57
	1908	9.50-10.00	9.63	10.25-10.75	13.50	14.87-16.12
September	1910	13.00-14.00	13.50	15.72-16.22	14.76	14.57-15.44
	1909	10.75-11.25	11.50	15.72-16.22	16.19-16.41	13.16-14.04
	1908	9.50-10.00	9.38	13.00-13.75	13.75	14.38-15.25
October	1910	13.50-14.00	13.62	14.20-15.21	14.76	13.51-14.39
	1909	11.00-12.00	11.75	14.70-15.21	16.41-16.84	12.63-13.51
	1908	10.00-10.50	9.50- 9.63	12.25-13.00	13.75	14.00-14.87
November	1910	13.00-13.75	12.87-13.00	15.21-16.24	14.76-15.11	13.16-14.04
	1909	10.50-11.50	11.25	15.21-15.72	16.19-16.41	11.93-12.81
	1908	8.00- 8.75	8.75	12.25-12.50	14.00	13.12-14.46
December	1910	10.25-11.00	11.37	14.20-15.21	13.60	13.16-14.04
	1909	11.00-11.50	11.25	15.21-15.72	15.11-15.54	11.58-12.46
	1908	8.00- 8.50	8.25- 8.63	12.25-13.00	14.00-14.25	12.63-13.50

OUR FOREIGN TRADE IN ANIMALS AND ANIMAL PRODUCTS.

The extent of our international trade in farm animals and their products is shown in the following tables of imports and exports of articles which come in this category. The exports last year again show a heavy decline because of the increased demands of the home markets and the continued scarcity and high prices of most of these products. The total value of the shipments for the calendar year 1910, as shown in the first table below, was $190,650,021, which is $22,293,883 less than the total for 1909, a decline of 10.47 per cent.

The rapidity with which our surplus of animal products has diminished in recent years may be judged by the fact that four years ago the total value of the exports of these products was, in round figures, $297,000,000, which is $106,000,000 more than the total for 1910. Expressed in terms of percentage this represents a falling off of 36 per cent in four years.

The imports of animal products in 1910 totaled $150,178,760. This is a considerably less amount than the total for 1909, although

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quite an increase compared with 1908. It may be remembered, however, that the import trade of 1909 was abnormally large; it was therefore but natural that there should have been some reaction in the following year.

EXPORTS.

All the important items of meat food products suffered a noticeable decline in 1910. The most seriously affected were bacon, live cattle, and fresh beef, all of which were fully 40 per cent below the totals of 1909. The situation as regards our rapidly waning surplus of beef is well shown by comparing the exports of 1910 with those of 10 years ago—1900. When this is done it is seen that the combined exports of live cattle and fresh beef in 1900 were just five times as large as those of 1910.

Of the other large items in the export table hams and oleo oil show a considerable falling off also. A few of the items show some increase, but these are mostly of minor importance, such as eggs, butter, and oleomargarin.

Exports of farm animals and their products, calendar years 1908–1910.

Items.	1908	1909	1910	Value, 1910.
Animals:				
Cattle....number..	277,036	184,957	109,629	$9,464,580
Hogs....do....	29,005	11,886	4,019	46,387
Horses....do....	18,516	23,428	29,359	4,328,623
Mules....do....	4,925	4,162	6,458	1,012,689
Sheep....do....	100,644	54,613	52,638	203,796
All other, including fowls....value [1]..	$235,196	$282,692	....	236,336
Dairy products:				
Butter....pounds..	8,918,091	2,925,730	3,104,175	788,767
Cheese....do....	10,190,843	3,501,214	2,768,681	435,629
Milk, condensed....value..	$1,997,689	$1,012,689	[2] 12,687,937	994,216
Eggs....dozen..	6,564,971	4,948,435	5,683,208	1,328,992
Feathers....value..	$451,267	$383,773	....	230,412
Grease....do....	$4,988,477	$5,107,620	....	4,544,097
Hair....do....	$1,050,531	$1,008,524	....	1,289,348
Hides and skins....pounds..	14,915,857	9,922,887	30,586,908	3,506,825
Leather:				
Sole....do....	31,940,839	32,469,344	38,615,004	8,419,475
Upper....value..	$19,752,118	$23,797,800	....	25,777,466
Meat products:				
Beef—				
Canned....pounds..	17,455,069	16,649,712	11,503,037	1,330,048
Fresh....do....	156,133,985	93,742,451	55,538,924	5,911,108
Salted, etc....do....	44,316,339	43,943,209	35,335,923	3,071,975
Pork—				
Canned....do....	4,656,252	5,628,928	3,715,803	438,396
Fresh....do....	18,668,365	2,417,185	907,229	120,523
Pickled....do....	100,337,245	46,742,815	41,488,829	4,806,246
Bacon....do....	264,788,376	212,551,671	128,269,744	17,880,082
Hams and shoulders....do....	220,829,141	195,765,704	131,181,642	17,884,237
Lard....do....	581,934,236	458,261,434	368,831,681	45,935,897
Lard compounds....do....	76,739,375	73,245,815	71,993,638	7,258,758
Mutton....do....	1,469,449	1,640,572	1,997,099	220,104
Oleo oil and neutral lard....do....	195,213,681	161,273,364	115,161,034	13,063,207
Oleomargarin....do....	2,739,662	3,104,541	3,654,670	387,497
Tallow....do....	70,489,762	50,113,092	16,262,289	1,119,033
Sausage....do....	9,063,349	7,421,836	3,947,900	501,669
Sausage casings....value..	$3,602,807	$4,357,133	....	4,552,691
Poultry and game....do....	$794,533	$827,324	....	658,531
Animal oil....gallons..	1,021,416	2,167,846	1,322,293	728,920
All other meat products....value..	$3,306,666	$2,645,921	....	2,173,471
Total annual value....	$246,495,867	$212,943,904	....	190,650,021

[1] Where values are given quantities are not stated in returns.
[2] Quantities for 1908 and 1909 not stated.

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IMPORTS.

The imports of animal products reached their highest magnitude in 1909. This abnormally large trade fell off in 1910 to the extent of $50,000,000, or 25 per cent. The latter year's total, which, according to the table below, amounted to $150,178,769, was, however, an advance of 35 per cent on the total for 1908.

As usual, about three-fourths of this total is furnished by two items—hides and wool. The imports of hides and skins amounted to fully one-half the entire year's total, while raw wool was just under one-fourth.

The chief falling off in 1910 was in wool. In round figures 180,000,000 pounds were imported, as against 312,000,000 pounds in 1909. Cattle hides fell off heavily also. Only two items of any importance showed increases, namely, live cattle and cheese. Although subject to a duty, nearly all the cattle were brought in for feeding and slaughter.

The receipts of foreign cheese have of late years become increasingly important. It may be seen the quantity annually imported is rapidly approaching the fifty-million-pounds mark. The great bulk of this cheese comes from Italy and Switzerland, the former country supplying the somewhat larger share. The imports from Italy in 1910 reached 18,253,494 pounds. The average price of all the cheese imports was 17.20 cents a pound.

Imports of farm animals and their products, calendar years 1908–1910.

Items.	1908	1909	1910	Value, 1910.
Animals:				
Cattle....number..	112,102	153,902	211,230	$3,261,023
Horses....do....	5,224	9,580	10,714	3,171,234
Sheep....do....	125,556	127,019	56,201	408,981
All other, including fowls....value [1]..	$514,539	$712,756	....	861,767
Bones, hoofs, and horns....do....	$631,967	$945,028	....	1,200,190
Bristles....pounds..	2,254,349	4,059,222	3,699,827	3,107,299
Dairy products:				
Butter....pounds..	261,161	1,416,633	1,209,473	282,474
Cheese....do....	33,793,726	37,795,506	43,966,873	7,563,276
Cream [2]....gallons..	....	....	1,858,652	1,495,746
Feathers, crude....value..	$4,802,029	$6,603,656	....	6,455,630
Glue....pounds..	5,648,471	7,718,780	9,005,853	867,757
Grease and oils....value..	$960,420	$1,050,053	....	1,362,604
Hair, animal, unmanufactured....do....	$3,056,131	$3,627,565	....	2,777,525
Hides and skins:				
Cattle hides....pounds..	137,922,575	279,044,262	221,969,098	32,925,374
Goatskins....do....	75,857,983	115,167,176	100,719,480	27,223,492
Sheepskins....do....	20,138,987	63,771,930	59,669,263	9,869,596
Tanned skins....value..	$1,764,578	$2,085,720	....	1,699,599
All other....pounds..	94,527,337	67,730,147	23,562,879	4,033,413
Hide cuttings....value..	$1,140,997	$1,506,756	....	1,612,720
Meat products:				
Sausage casings....value..	$2,151,618	$2,388,738	....	2,607,097
All other....do....	$710,132	$778,759	....	1,289,525
Wool, raw....pounds..	142,559,384	312,131,171	180,134,981	36,102,447
Total value....	$111,411,077	$200,407,539	....	150,178,769

[1] Where values are given the quantities are not stated in the returns.
[2] Not separately enumerated until July 1, 1910.

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LEGAL STANDARDS FOR DAIRY PRODUCTS.

In the following statement, prepared in the Dairy Division, are given the standards for dairy products as established by law in the several States and Territories, so far as obtainable.

The percentages stated represent minimum standards in all cases unless otherwise expressed. States not named are understood to have no laws prescribing standards for dairy products or else to leave the subject to local ordinances.

Standards for ice cream are in force in a few of the States. A standard of 14 per cent milk fat for this product has been adopted by the States of Missouri, Kentucky, and Indiana. Idaho has a 12 per cent standard, and the city of Memphis, Tenn., by municipal ordinance, an 8 per cent standard.

Legal standards for dairy products, 1910.

States.	Milk.			Skim milk.	Cream.	Butter.	Whole-milk cheese.	Condensed milk.	
	Total solids.	Solids not fat.	Fat.	Total solids.	Fat.	Fat.	Total solids.	Total solids.	Fat.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Alabama	None; municipal control.								
California		8.5	3	9.25	18	80	[1] 30	24.5	7.7
Colorado		8.5	3.25	9.25	18	82.5	[1] 35	28	7.7
Connecticut	11.75	8.5	3.25						
District Columbia		9	3.5	9.3	20	[2] 83			
Delaware	None; municipal control.								
Florida	None; municipal control.								
Georgia	12	8.5	3.25	9.25	18	82.5	50	28	7
Hawaii	11.5	8.5	3					28	7.7
Idaho	11	8	3	9.25	18	82.5	[1] 30	28	7.7
Illinois		8.5	3	9.25	18	82.5	50	28	7.7
Indiana		8.5	3.25	9.25	18	82.5	50	28	
Iowa	12.5		3		15	80			
Kansas			3.25						
Kentucky	12	8.5	3.25	9.25	18	82.5	50	28	7.7
Louisiana		8.5	3.5	8.00	18	82.5	[1] 50	28	7.7
Maine	11.75	8.5	3.25						
Maryland	12.5		3.5					([3])	
Massachusetts	12.15		3.35	9.3	15				
Michigan	12.5		3	Sp. gr. 32	15				
Minnesota	13		3.5		20	80	45		
Missouri		8.75	3.25	9.25	18	82.5	50	28	7.7
Montana	12	9	3		15				
Nebraska			3		18				
New Hampshire	12			9	18	80			
New Jersey	12		3		16				
New Mexico	None; municipal control.								
New York	11.5		3						([3])
North Carolina		8.5	3.25	9.25	18	82.5	[4] 50	28	7.7
North Dakota	12		3		15				
Ohio	12		3			80		([3])	
Oklahoma	12.5		3		18			28	7
Oregon	12.2	9	3.2		20		[1] 30	22	4.5
Pennsylvania		None; municipal control.			15				
Porto Rico	12		3						
Rhode Island	12		2.5						
South Carolina	None; municipal control.								
South Dakota		8.5	3.25	9.25	18	80	[4] 50	28	7.7
Tennessee		8.5	3.25		18	82.5	[4] 50	28	7.7
Texas		8.5	3.25						
Utah	12	9	3.2		18	80		28	7
Vermont	[5] 12.5	9.25	4						
Virginia		8.5	3.25	9.25	18	82.5	[4] 50	28	7.7
Washington	12	8.75	3.25	9.3	18		[1] 30		
Wisconsin		8.5	3	9	18	82.5	50	28	8
Wyoming	12		2.4			80	[1] 20		([3])

[1] Per cent of fat.
[2] Not over 12 per cent water or 5 per cent salt.
[3] Proportion of fat to total solids must be the same as in the crude milk.
[4] Per cent of fat in total solids.
[5] May and June, 12.

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STATE LIVE-STOCK SANITARY OFFICERS.

United States Live Stock Sanitary Association: President, J. F. De Vine, Goshen, N. Y.; vice presidents, Fred Walker, Boston, Mass.; Charles Keane, Sacramento, Cal.; G. T. Bryan, Guthrie, Okla.; W. F. Crewe, Devils Lake, N. Dak.; M. H. Reynolds, St. Anthony Park, Minn.; secretary and treasurer, J. J. Ferguson, Union Stock Yards, Chicago, Ill.

Alabama.—State live-stock sanitary board: R. F. Kolb, chairman and commissioner of agriculture, Auburn; Dan T. Gray, Auburn Polytechnic Institute, Auburn; C. A. Cary, secretary and State veterinarian, Auburn.

Arizona.—Live-stock sanitary board: George Pusch, chairman, Tucson; O. H. Christy, Phoenix; J. W. Stewart, Simmons; J. D. Carter, secretary, Phoenix; J. C. Norton, Territorial veterinarian, Phoenix.

Arkansas.—J. F. Stafford, veterinarian, Agricultural College and Experiment Station, Fayetteville.

California.—Charles Keane, State veterinarian, Sacramento.

Colorado.—State board of stock-inspection commissioners: A. K. Stevens, president, Iola; H. W. Potter, treasurer, La Junta; E. McCrillis, secretary, Denver; Charles G. Lamb, State veterinarian, Denver.

Connecticut.—Heman O. Averill, commissioner of domestic animals, Hartford.

Delaware.—State live-stock sanitary board: O. A. Newton, president, Bridgeville; Newton L. Grubb, vice president, Grubbs; Edward W. Jenkins, Dover; J. R. Kuhns, secretary and State veterinarian, Dover.

Florida.—Joseph Y. Porter, State health officer, Jacksonville.

Georgia.—Peter F. Bahnsen, State veterinarian, Atlanta.

Hawaii.—V. A. Nörgaard, Territorial veterinarian, Honolulu.

Idaho.—State live-stock sanitary board: L. L. Ormsby, president, Boise; Charles H. Baird, Forest; Thomas C. Stanford, Carey; William H. Larkins, Turner; Clay Vance, Dickey; Arthur Pence, Hot Springs; Charles W. Leaf, Fernwood.

Illinois.—State board of live-stock commissioners: Henry J. Beer, Blue Island; T. F. Russell, Pana; Philip S. Haner, Taylorville; C. A. Lowery, secretary, Springfield; James M. Wright, State veterinarian, Chicago.

Indiana.—William E. Coover, State veterinarian, Indianapolis.

Iowa.—James I. Gibson, State veterinarian, Des Moines.

Kansas.—J. H. Mercer, live-stock sanitary commissioner, Topeka.

Kentucky.—State live-stock sanitary board: M. C. Rankin, chairman, Frankfort; E. S. Good, Agricultural Experiment Station, Lexington; G. N. McGrew, Bayou; J. L. Dent, Leitchfield; Fred R. Blackburn, Stanton.

Louisiana.—E. Pegram Flower, State veterinarian and secretary of State live-stock sanitary board, Baton Rouge.

Maine.—V. W. Carll, State live-stock sanitary commissioner, Augusta; R. S. Smith, dairy inspector, Augusta.

Maryland.—State live-stock sanitary board: Wade H. D. Warfield, Sykesville; E. Gittings Merryman, Cockeysville; Charles W. Simpers, North East.

Massachusetts.—Fred Freeland Walker, chief of cattle bureau, State board of agriculture, 136 State House, Boston.

Michigan.—State live-stock sanitary commission: C. A. Tyler, Coldwater; H. H. Hinds, Stanton; T. F. Marston, Bay City.

Minnesota.—State live-stock sanitary board: C. E. Cotton, president, Minneapolis; C. A. Nelson, vice president, Fridley; M. H. Reynolds, St. Anthony Park; P. H. Grogan, St. James; Carl Sholin, Milaca; S. H. Ward, secretary and State veterinarian, Old Capitol, St. Paul.

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Mississippi.—State live-stock sanitary board: H. E. Blakeslee, chairman, Jackson; J. W. Day, Crystal Springs; J. M. Aldrich, Michigan City; W. L. Hutchinson, secretary, Agricultural College; James Lewis, State veterinarian, Agricultural College.

Missouri.—D. F. Luckey, State veterinarian, Columbia.

Montana.—State live-stock sanitary board: William Treacy, chairman, Helena.

Nebraska.—A. Bostrom, State veterinarian, Lincoln.

Nevada.—T. T. Richardson, State veterinarian, Fallon; Stan. C. Mitchell, secretary State sheep commission, Reno.

New Hampshire.—State cattle commission: N. J. Bachelder, Concord; Irving A. Watson, Concord; Richard Pattee, Plymouth.

New Jersey.—State board of health: John H. Capstick, president, Montville; Bruce S. Keator, secretary, Asbury Park.

State tuberculosis commission: Joseph S. Frehlinghuysen, president, Raritan; Franklin Dye, secretary, Trenton.

New Mexico.—Cattle sanitary board: C. L. Ballard, president, Roswell; W. H. Jack, Silver City; W. W. Cox, Organ; B. F. Pankey, Lamy; W. D. McDonald, Carrizozo; W. J. Linwood, secretary, Albuquerque.

Sheep sanitary board: Harry F. Lee, secretary, Albuquerque.

New York.—Raymond A. Pearson, commissioner of agriculture, Albany. J. G. Wills, chief veterinarian, department of agriculture, Albany.

North Carolina.—W. A. Graham, commissioner of agriculture, Raleigh. W. G. Chrisman, State veterinarian.

Committee on live-stock sanitary control and animal husbandry: A. Cannon, chairman, Horse Shoe; K. W. Barnes, Lucama; W. J. Shuford, Hickory; J. P. McRae, Laurinburg.

North Dakota.—State live-stock sanitary board: W. L. Richards, Dickinson; T. B. Dawson, Lamoure; Andrew Veitch, Grand Forks; J. W. Roberson, Coal Harbor; E. J. Walsh, Willow City; W. F. Crewe, State veterinarian, Devils Lake.

Ohio.—Paul Fischer, State veterinarian, Reynoldsburg. F. A. Zimmer, chief field veterinarian, Williamsburg. Morgan B. Lamb, specialist in tuberculosis and cattle diseases, Columbus.

Oklahoma.—State board of agriculture: G. T. Bryan, president, Oklahoma; Benj. Hennessy, secretary, Oklahoma; M. F. Ikard, superintendent of live-stock inspection, Chickasha.

Oregon.—W. H. Lytle, State veterinarian, Pendleton.

State board of health: A. C. Smith, president, Portland; C. S. White, secretary, Selling Building, Portland.

Board of sheep commissioners: Charles Cleveland, president, Gresham; Herbert Boylen, secretary, Pendleton; H. C. Rooper, Antelope.

Pennsylvania.—State live-stock sanitary board: Gov. John K. Tener, president; James Foust, vice president; C. J. Marshall, secretary and State veterinarian; T. E. Munce, deputy State veterinarian—all at Harrisburg; Carl W. Gay, Philadelphia.

Porto Rico.—Thomas A. Allen, veterinary inspector, health office, San Juan.

Rhode Island.—John S. Pollard, State veterinarian, Providence; John J. Dunn, secretary, State board of agriculture, Providence.

South Carolina.—M. Ray Powers, state veterinarian, Clemson College.

South Dakota.—State live-stock sanitary board: F. M. Stewart, president, Buffalo Gap; F. R. Cook, secretary, Belle Fourche; Thomas H. Hicks, State veterinarian, Milbank.

Tennessee.—J. H. McDowell, State live-stock inspector, Nashville.

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Texas.—State live-stock sanitary commission: W. N. Waddell, president, Fort Worth; Al. McFadden, secretary, Victoria; J. W. Johnson, San Angelo.

Utah.—A. Carrington Young, State veterinarian, McIntyre Building, Salt Lake City.

State board of sheep commissioners: L. R. Anderson, president, Salt Lake City; Arthur A. Callister, secretary, Salt Lake City.

Vermont.—Fred L. Davis, State cattle commissioner, White River Junction.

Virginia.—J. G. Ferneyhough, State veterinarian, Burkeville.

State live-stock sanitary board: L. E. Johnson, chairman, Roanoke; P. F. St. Clair, Bane; B. F. Kirkpatrick, Lynchburg; J. C. Carrington, Charlotte Court House; P. B. Barringer, Blacksburg; C. I. Wade, secretary, Christiansburg.

Washington.—S. B. Nelson, State veterinarian, Pullman.

West Virginia.—John M. Millan, secretary, board of agriculture, Charleston.

Wisconsin.—Live-stock sanitary board: George Wylie, president, Morrisonville; R. E. Katz, secretary, Madison; A. H. Hartwig, State veterinarian, Madison.

Wyoming.—B. F. Davis, State veterinarian, Cheyenne.

State board of live-stock commissioners: J. C. Underwood, Underwood; Thomas Bell, Lusk; Fred G. S. Hesse, Buffalo.

State board of sheep commissioners: Frank S. King, Laramie; J. J. Bentley, Sheridan; Lewis Barker, Casper.

CONTAGIOUS DISEASES OF ANIMALS IN FOREIGN COUNTRIES.

A number of foreign, particularly European, countries maintain sanitary supervision over their live stock and issue periodical reports showing the status of contagious diseases of domestic animals from time to time. The reports covering the year 1910 have been tabulated and the results are shown in the series of tables next following.

The problem of controlling foot-and-mouth disease proved, as heretofore, a difficult one in many of the European countries. All the countries of western Europe recognize the necessity of adopting very prompt and thorough measures of eradication, and these countries were practically free from the disease at the close of the year. Most of them, however, including Great Britain, had to deal with one or more isolated outbreaks during the year. The central and southern European countries were not so fortunate. Although only Italy and Switzerland were affected during the first part of the year, the disease later traveled northward with great rapidity, and the efforts to prevent its spread seemed quite unavailing.

The extreme contagiousness of the foot-and-mouth infection is well illustrated in the tables for Austria, Hungary, and Germany, especially the two former. These two countries were entirely free from the disease during the first six months of 1910, but it gained a foothold in July and afterwards spread so rapidly that both countries were entirely overrun at the close of the year.

The details, showing whenever possible the monthly and annual status of animal diseases in each country, follow:

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AUSTRIA.

During 1909 Austria was but very slightly infected with foot-and-mouth disease; there were, in fact, no outbreaks at all from December, 1909, to June, 1910. In the last six months of 1910, however, the disease again became prevalent and soon made alarming headway. The table demonstrates how rapidly the contagion spreads when it has become epizootic. Starting with 80 infected farms in July, the year closed with the huge total of 34,303, and the reports by provinces and districts show that the entire country had become permeated.

There was not much change in the status of the other diseases as compared with 1909, excepting hog cholera, the outbreaks of which were nearly four times as numerous in the last four months of 1910 as they were during the same period in 1909. The returns indicate that tuberculosis is rare among Austrian cattle.

Number of premises infected with contagious diseases of animals in Austria at monthly periods during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Foot-and-mouth disease	......	......	......	......	......	......
Anthrax	16	16	18	13	27	58
Blackleg	......	2	11	4	13	17
Hemorrhagic septicemia	......	......	......	......	......	1
Glanders	15	17	16	12	12	15
Sheep pox	......	......	......	......	......	......
Coital exanthema	47	67	145	279	233	324
Scab:						
Solipeds	28	52	96	105	70	53
Sheep	1	1	1	2	2	2
Goats	10	9	13	16	26	45
Rabies	26	25	35	26	38	27
Hog cholera and swine plague	703	776	580	585	530	560
Erysipelas of swine	31	34	46	67	73	146
Tuberculosis (bovine)	......	6	27	7	37	28
Diseases.	**July.**	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Foot-and-mouth disease	80	246	1,415	9,426	23,793	34,303
Anthrax	152	180	87	65	28	16
Blackleg	29	21	19	14	7	8
Hemorrhagic septicema	1	2	......	......	......	1
Glanders	18	14	15	17	12	10
Sheep pox	......	......	......	......	......	5
Coital exanthema	150	84	89	58	49	45
Scab:						
Solipeds	74	68	53	48	38	24
Sheep	1	2	2	8	12	59
Goats	21	9	1	2	1	1
Rabies	30	33	26	18	20	25
Hog cholera and swine plague	635	795	1,253	1,585	1,670	1,541
Erysipelas of swine	481	442	483	374	330	101
Tuberculosis (bovine)	30	36	22	19	7	3

Diseases scheduled but no cases reported in 1910: Rinderpest, pleuropneumonia, and dourine.

BELGIUM.

Animal diseases in Belgium were on the whole less prevalent in 1910 than in 1909. There were fewer cases of glanders, foot-and-mouth disease, blackleg, sheep scab, and foot rot of sheep. On the

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other hand, there were a few more cases of anthrax and a marked increase in rabies. The totals in 1909 of the latter were 39 cases and 59 suspects. Foot-and-mouth disease was found in one stable in August, there having been no previous cases for 17 months. The figures showing tuberculous carcasses passed for food and those condemned are of interest as indicating the policy of the Belgian inspection service in passing such carcasses as are so slightly affected as to be safely used for food.

Cases of contagious diseases of animals in Belgium during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Glanders and farcy		1	2	2		
Foot-and-mouth disease						
Rabies:						
Cases	2	5	1	11	15	19
Suspects (slaughtered)	2	1	4	97	14	40
Anthrax	49	48	59	70	66	39
Blackleg	11	16	11	12	16	17
Sheep scab						
Foot rot of sheep			40		10	
Tuberculosis:						
Passed for food	1,612	1.651	1,786	1,672	1,695	1,755
Condemned	471	449	673	519	524	421

Diseases.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Glanders and farcy	2	2	1	1	1		12
Foot-and-mouth disease		15			1	14	30
Rabies:							
Cases	20	32	10	8	4	6	133
Suspects (slaughtered)	28	38	7	12	3	2	248
Anthrax	42	49	57	47	74	47	647
Blackleg	33	22	29	30	25	15	237
Sheep scab			8				8
Foot rot of sheep				1			51
Tuberculosis:							
Passed for food	1,878	1.906	2.222	2,085	1,987	2,212	22,461
Condemned	457	487	568	489	428	388	5,874

DENMARK.

The Danish reports of animal diseases for 1910 are noteworthy in respect to two items only, namely, the appearance of foot-and-mouth disease in November, and the increase in the outbreaks of erysipelas of swine. The total of the latter in 1910 was 743; in 1909, 385, and in 1908, 330; the disease therefore increased nearly 100 per cent in 1910.

Outbreaks of contagious diseases of animals in Denmark during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Anthrax	18	31	23	32	15	11
Foot-and-mouth disease						
Spinal meningitis	3		1	4	5	2
Glanders	3	2	1			2
Malignant catarrhal fever	8	6	9	9	16	12
Hog cholera, chronic	1	11	14	11	15	5
Erysipelas of swine, acute	20	23	19	26	38	55

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Outbreaks of contagious diseases of animals in Denmark during 1910—Contd.

Diseases.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Anthrax	8	12	16	15	18	12	211
Foot-and-mouth disease	......	......	......	......	1	3	4
Spinal meningitis	2	1	1	2	1	5	27
Glanders	......	......	1	2	1	......	12
Malignant catarrhal fever	10	8	5	4	6	11	104
Hog cholera, chronic	8	6	4	5	7	1	88
Erysipelas of swine, acute	81	127	121	100	74	64	743

Diseases scheduled but no outbreaks reported in 1910: Rinderpest, pleuropneumonia, sheep pox, foot rot of sheep, sheep scab, and acute hog cholera.

FRANCE.

The status of contagious diseases of animals in France during 1910, as given in the table below, shows no great variation from the figures for 1909 except in the case of erysipelas of swine, which shows a considerable reduction. The number of outbreaks of this disease in 1909 was 1,014, as against 658 in 1910, the reduction being equivalent to 35 per cent. There has been no foot-and-mouth disease in France since May, 1909.

Status of contagious diseases of animals in France during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Sheep scab (outbreaks)	12	8	8	5	9	11
Sheep pox (outbreaks)	3	2	......	4	9	1
Anthrax (outbreaks)	37	26	39	37	38	30
Blackleg (outbreaks)	97	73	58	71	50	74
Glanders and farcy:						
Number of outbreaks	28	15	14	21	25	21
Animals slaughtered	42	20	17	31	29	29
Rabies (cases)	104	116	145	166	160	158
Erysipelas of swine (outbreaks)	57	40	37	33	27	63
Hog cholera (outbreaks)	52	40	42	63	53	45

Diseases.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Sheep scab (outbreaks)	11	5	15	16	11	13	124
Sheep pox (outbreaks)	7	15	22	22	11	7	103
Anthrax (outbreaks)	40	49	49	52	31	27	455
Blackleg (outbreaks)	66	89	110	111	101	117	1,017
Glanders and farcy:							
Number of outbreaks	16	27	13	17	15	14	226
Animals slaughtered	26	37	15	21	22	14	303
Rabies (cases)	133	137	106	112	119	98	1,554
Erysipelas of swine (outbreaks)	81	84	62	53	55	66	658
Hog cholera (outbreaks)	33	33	99	56	23	34	573

Diseases scheduled but no outbreaks reported in 1910: Foot-and-mouth disease, pleuropneumonia, and dourine.

GERMANY.

The condition of contagious diseases of animals in Germany in 1910 was much less satisfactory than in 1909. Foot-and-mouth disease was eradicated in May, 1909, no further outbreaks being reported

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in that year; but in June of the following year the disease reappeared in epizootic form and gradually spread until by December the country was practically overrun by it. There was some increase also in swine disease and glanders. A clean record for pleuropneumonia was just missed because of one outbreak in December.

Number of farms infected with contagious diseases of animals in Germany at monthly periods during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Glanders and farcy	31	29	24	22	16	22
Pleuropneumonia						
Foot-and-mouth disease	2		2	1	1	17
Hog cholera and swine plague	1,286	1,324	1,540	1,708	1,770	1,815

Diseases.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Glanders and farcy	19	33	27	32	35	33
Pleuropneumonia						1
Foot-and-mouth disease	124	172	183	552	2,101	4,300
Hog cholera and swine plague	1,626	1,555	1,605	1,699	1,707	1,533

GREAT BRITAIN AND IRELAND.

The British authorities had to deal with an outbreak of foot-and-mouth disease, which occurred in Yorkshire, in July, 1910. The origin of the outbreak could not be ascertained; it was, however, promptly discovered and suppressed. There were found affected 13 cattle and 2 swine, and these, with 257 other animals that had become exposed to the disease, were slaughtered. The situation in regard to other diseases of animals in 1910 was favorable, there having been a decrease compared with the previous year in all except anthrax, and the increase in the latter was very slight.

Annual status of contagious diseases of animals in Great Britain, 1903–1910.

Disease.	1903	1904	1905	1906	1907	1908	1909	1910
Foot-and-mouth disease:								
Outbreaks						3		2
Cases						112		15
Glanders and farcy:								
Outbreaks	1,456	1,529	1,214	1,070	850	785	536	351
Cases	2,499	2,658	2,068	2,012	1,934	2,421	1,761	1,014
Sheep scab:								
Outbreaks	1,792	1,418	918	534	751	849	685	556
Cases	24,431							
Anthrax:								
Outbreaks	767	1,049	970	939	1,089	1,108	1,316	1,496
Cases	1,143	1,589	1,317	1,325	1,466	1,426	1,700	1,776
Swine fever:								
Outbreaks	1,478	1,196	817	1,280	2,336	2,067	1,651	1,598
Swine slaughtered (diseased or exposed)	7,933	5,603	3,876	7,359	11,275	14,096	14,316	15,543

There have been no outbreaks of cattle plague, pleuropneumonia, or rabies during the above period.

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There was little change in the prevalence of contagious diseases of animals in Ireland during 1910 as compared with 1909. There were fewer outbreaks of anthrax and parasitic mange but more of sheep scab and swine fever. There was one outbreak of glanders, involving two animals, of which there had been none the two previous years.

Annual status of contagious diseases of animals in Ireland, 1903–1910.

Disease.	1903	1904	1905	1906	1907	1908	1909	1910
Anthrax:								
Outbreaks	4	4	4	4	3	8	9	6
Cases	11	7	4	8	5	11	9	12
Glanders and farcy:								
Outbreaks	5	11	30	8	7	....	....	1
Cases	7	34	107	16	12	....	....	2
Rabies:								
Cases	2	....	....	....	....	....	....	....
Sheep scab:								
Outbreaks	655	486	339	256	333	384	445	463
Cases	8,306	6,433	4,253	3,513	5,198	6,182	7,129	6,075
Swine fever:								
Outbreaks	175	181	137	95	163	159	57	106
Cases	1,079	931	1,416	1,103	2,789	3,625	373	514
Epizootic lymphangitis:								
Outbreaks	....	1	10	1	....	....	....	....
Cases	....	1	25	1	....	....	....	....
Parasitic mange:								
Outbreaks	195	162	169	85	77	42	77	62
Cases	295	252	322	130	94	59	110	82

In addition to the above the following diseases are scheduled in Ireland, but no cases were reported: Cattle plague, foot-and-mouth disease, pleuropneumonia, and sheep pox.

HUNGARY.

The main feature of the animal-disease situation in Hungary during 1910 was the visitation of foot-and-mouth disease in the latter half of the year. The conditions which prevailed were very similar to those already described for the allied country, Austria. If anything, the outbreak was even more severe in Hungary. At the close of the year the disease had gained a foothold in every part of the country, the report for the first week in December showing 38,086 farms to have been infected at that time.

As regards most of the other diseases the number of outbreaks was considerably less than in 1909, and this refers especially to erysipelas of swine. Hog cholera, however, was more prevalent last year.

The Hungarian reports include Croatia and Slavonia.

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Number of premises infected with contagious diseases of animals in Hungary at monthly periods during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Anthrax	152	133	158	156	199	283
Rabies	218	208	272	253	307	284
Glanders	29	31	33	60	66	61
Sheep pox	169	150	130	123	95	87
Coital exanthema:						
Solipeds	......	......	17	136	147	102
Cattle	4	16	39	56	95	101
Scabies:						
Solipeds	56	101	177	443	478	396
Sheep	46	163	182	278	294	240
Barbone of buffalo	......	2	1	2	5	11
Erysipelas of swine	185	123	99	143	218	591
Hog cholera	1,409	978	794	858	1,125	1,649

Diseases.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Anthrax	357	353	316	293	226	177
Rabies	230	232	250	244	232	203
Glanders	59	57	53	58	59	52
Foot-and-mouth disease	33	261	1,440	5,432	21,817	38,086
Sheep pox	113	148	174	240	284	323
Coital exanthema:						
Solipeds	20	14	3	......	......	......
Cattle	90	62	34	28	15	18
Scabies:						
Solipeds	251	187	137	113	107	71
Sheep	195	164	127	122	41	19
Barbone of buffalo	8	5	7	5	3	4
Erysipelas of swine	1,171	1,176	874	779	453	331
Hog cholera	3,272	4,326	5,466	5,125	4,311	3,221

Hungary is declared to be free from rinderpest and pleuropneumonia, and no outbreaks of dourine were reported in 1910.

INDIA.

The reports of the British veterinary departments in India indicate that the most serious diseases of domestic animals in that country are rinderpest, hemorrhagic septicemia, and foot-and-mouth disease. A considerable number of fatalities are also caused by anthrax and blackleg among cattle, and by surra and glanders among horses.

Rinderpest was the cause of about 4,000 more fatalities in 1910 than in the previous year, while the reverse was the case with hemorrhagic septicemia. Foot-and-mouth disease was also less prevalent during 1910.

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Number of deaths from contagious diseases of animals in stated Provinces of British India during the fiscal year 1910.

Diseases.	United Provinces.	Punjab.	Bengal.	Eastern Bengal and Assam.	Total.
Rinderpest:					
Bovines	17,071	18,055	8,869	28,860	72,855
Others	300	855		728	1,883
Foot-and-mouth disease:					
Bovines	3,677	3,899	2,374	7,783	17,733
Others	2	468		65	535
Anthrax:					
Equines		7	6	22	35
Bovines	1,333	55	812	1,820	4,020
Others		201		9	210
Hemorrhagic septicemia:					
Bovines	2,839	18,255	3,130	3,327	27,551
Others	19	878		4	901
Glanders	32	22	169	14	237
Surra	250	452		29	731
Blackleg	679	1,552	737	38	3,006
Rabies	2				2
Tetanus	64				64
Pleuropneumonia	30				30
Other contagious diseases	400	6,848	2,363	9,082	18,693

ITALY.

The Italian authorities accomplished great results during the year 1910 in stamping out anthrax and blackleg. There was an average of about 400 cases of anthrax each month in 1909, and none at all were reported in 1910. During 1909 there were recorded 330 cases of blackleg, while the table shows only a single case in 1910. Foot-and-mouth disease, although somewhat prevalent, was much less so than in 1909; the reverse, however, was the case with sheep scab.

Cases of contagious diseases of animals in Italy at monthly periods in 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Blackleg				1		
Foot-and-mouth disease	6,599	4,134	2,489	1,855	652	366
Glanders and farcy	29	10	18	13	15	15
Pox:						
Horses			2			
Cattle						
Sheep scab	4,452	3,419	5,135	7,128	6,898	6,426
Rabies	34	9	5	4	20	25
Infectious disease o swine	626	408	681	537	1,294	1,534
Contagious mammitis	705	582	1,333	923	2,820	1,413

Diseases.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Blackleg						
Foot-and-mouth disease	592	855	471	263	515	2,868
Glanders and farcy	13	9	6	7	7	8
Pox:						
Horses						
Cattle		27				
Sheep scab	4,857	4,300	4,675	2,137	258	847
Rabies	22	3	2	25	17	18
Infectious disease of swine	1,726	1,761	1,526	1,255	1,424	953
Contagious mammitis	1,730	4,713	4,730	2,945	2,595	550

There were no cases of anthrax, barbone of buffalo, or sheep pox.

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THE NETHERLANDS.

Foot-and-mouth disease was entirely absent during 1910 with the exception of four isolated outbreaks in the spring months. Compared with 1909 there was an increase in anthrax, swine erysipelas, and foot rot of sheep, and a decrease in sheep scab and glanders.

Cases of contagious diseases of animals in the Netherlands during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Anthrax	93	70	93	97	73	36
Rabies	....	....	2	2	1	....
Mange:						
Horses	....	....	....	5	....	1
Sheep	482	213	45	115	242	511
Erysipelas of swine	5	6	9	17	23	99
Foot rot	35	68	24	56	50	29
Glanders	4	....	....	....	1	1
Foot-and-mouth disease (outbreaks)	....	1	1	1	1	....

Diseases.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Anthrax	37	44	45	31	46	83	748
Rabies	....	....	2	1	....	....	8
Mange:							
Horses	5	....	....	....	1	....	12
Sheep	375	119	164	207	33	114	2,619
Erysipelas of swine	169	189	259	94	27	14	911
Foot rot	78	95	90	108	117	33	783
Glanders	....	2	....	....	....	1	9
Foot-and-mouth disease (outbreaks)	....	....	....	....	....	....	4

There were no reported cases of trichinosis of swine in 1910.

NORWAY.

The totals of the diseases tabulated below are all slightly in excess of the corresponding totals for 1909, the greatest difference being with anthrax, which increased from 293 to 368. It will be noticed there were two outbreaks of hog cholera and swine plague during the year, the one in December involving 20 animals. There had been no previous outbreak of this disease since October, 1908.

Cases of contagious diseases of animals in Norway during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Anthrax	25	21	41	43	45	31
Blackleg	4	4	8	4	6	9
Braxy of sheep	14	9	24	15	15	5
Malignant catarrhal fever	43	44	47	92	46	55
Hog cholera and swine plague	....	....	....	....	....	2

Diseases.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Anthrax	17	26	35	20	32	32	368
Blackleg	9	8	16	3	4	1	76
Braxy of sheep	....	....	....	3	14	7	106
Malignant catarrhal fever	58	59	35	45	27	35	586
Hog cholera and swine plague	....	....	....	....	....	20	22

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Diseases scheduled, but no outbreaks reported in 1910: Rinderpest, pleuropneumonia, foot-and-mouth disease, rabies, glanders, sheep pox, sheep scab, and foot rot of sheep.

SWEDEN.

The table below indicates that anthrax is the only disease of farm animals in Sweden that gives any serious trouble. The number of outbreaks in 1910 shows the disease to have been considerably more prevalent than it was in 1909, when the total was 224. An unusual feature last year was the visitation of foot-and-mouth disease in February, which, however, was promptly suppressed.

Outbreaks of contagious diseases of animals in Sweden during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.
Anthrax	30	30	42	36	51	35
Blackleg	2	1	2	2	4	13
Foot-and-mouth disease	......	3	......	......	......	......
Hog cholera	......	......	1	2	......	2
Erysipelas of swine	......	......	1	......	......	......

Diseases.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Anthrax	25	24	13	18	19	32	355
Blackleg	10	4	6	10	3	......	57
Foot-and-mouth disease	......	......	......	......	......	......	3
Hog cholera	1	......	......	......	......	......	6
Erysipelas of swine	......	......	......	......	2	......	3

Diseases scheduled but no outbreaks reported in 1910: Rinderpest, pleuropneumonia, glanders and farcy, sheep pox, sheep scab, foot rot, and rabies.

SWITZERLAND.

The Swiss report of animal diseases in 1910 is chiefly noticeable for the diminution of foot-and-mouth disease. Although prevalent in some degree throughout the year, the total number of cases was only 2,442, as against 19,625 in 1909. There was a decrease also in all the other diseases listed in the table except the swine diseases and blackleg, each of which showed a slight increase.

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Cases of contagious diseases of animals in Switzerland during 1910.

Diseases.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Blackleg	13	8	10	23	41	65	160	229	102	67	19	30	767
Anthrax	22	23	23	22	28	11	15	13	9	23	14	30	233
Foot-and-mouth disease:													
Cattle	502	377	104	70	73	134	122	232	368	73	15	61	2,131
Other animals	114	38	22		33	25	4	24	26	9		16	311
Glanders and farcy				6		3				5	3	4	21
Swine erysipelas and cholera	998	917	863	776	864	982	1,201	2,195	1,869	1,892	631	1,328	14,516
Sheep scab	11		3	265			1						280

Diseases scheduled but no cases reported in 1910: Pleuropneumonia and rabies.

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APPENDIX.

ORGANIZATION AND WORK OF THE BUREAU OF ANIMAL INDUSTRY.

A. D. Melvin, Chief of Bureau.
A. M. Farrington, Assistant Chief.
Charles C. Carroll, Chief Clerk.

The Bureau of Animal Industry has charge of the work of the United States Department of Agriculture relating to the live-stock industry. In general it deals with the investigation, control, and eradication of diseases of animals, the inspection and quarantine of live stock, the inspection of meat and meat food products, and with animal husbandry and dairying.

The bureau conducts the inspection of live stock, meats, and meat food products intended for interstate or foreign commerce, under the act of Congress of June 30, 1906, and also has charge of the inspection of import and export animals, the inspection of ships for the transportation of export animals, and the quarantine stations for imported animals. It investigates the existence of communicable diseases of live stock, makes original scientific investigations as to the nature, cause, and prevention of such diseases, and takes measures for their repression and eradication, frequently in cooperation with State and Territorial authorities. As part of this work a quarantine of the section infected with Texas or southern fever of cattle is maintained, the extermination of the tick which transmits this disease has been undertaken, and sheep scab and cattle mange are being eradicated from the West. The bureau makes investigations in the breeding and feeding of animals and in regard to dairy subjects, and supervises the manufacture of and interstate commerce in renovated butter. Reports of scientific investigations and treatises on various subjects relating to the live-stock industry are prepared and published.

A synopsis of the work of each division follows.

THE ANIMAL HUSBANDRY DIVISION.

George M. Rommel, *Chief.*

This division gathers information and makes studies and experiments concerning the breeding and feeding of farm animals and poultry, certifies to the pure breeding of animals imported into the United States for breeding purposes under paragraph 492 of the tariff act of August 5, 1909, and attends to correspondence and prepares publications on these subjects. The division is now engaged in experiments in regard to the harmful properties of cotton seed and cottonseed products when fed to hogs; a study of the shrinkage of beef cattle in shipment; experiments in breeding small animals; the study of cross breeding in sheep; the utilization of native goats for milk production; hybridizing the Grévy zebra with asses and horses; experiments to test the value of different systems of feeding poultry; a study of the cost of production of poultry and

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eggs; and a study of market and transportation problems connected with the egg and poultry trade.

Cooperative work with State agricultural experiment stations comprises investigations in animal nutrition at the Pennsylvania Station, in beef production at the Alabama Station, in horse breeding in Colorado, Iowa, and Vermont, in breeding milking Shorthorn cattle in Minnesota, in breeding Holstein-Friesian cattle in North Dakota, in poultry breeding and management in Maine, and in sheep breeding in Wyoming.

The staff of this division includes G. Arthur Bell, senior animal husbandman, in charge of certification of pedigrees; E. L. Shaw, senior animal husbandman, and Charles E. Snyder, animal husbandman, in charge of sheep and goat investigations; H. P. Armsby, in charge of animal nutrition investigations; W. F. Handschin, in charge of milking Shorthorn investigations; Rob R. Slocum, animal husbandman, in charge of poultry investigations; Harry M. Lamon, junior animal husbandman, in charge of market egg and poultry investigations; E. H. Riley, animal husbandman in animal breeding investigations; W. F. Hammond, superintendent of Morgan horse farm; John O. Williams, junior animal husbandman, in charge of Colorado horse-breeding station; W. F. Ward, junior animal husbandman in beef-cattle investigations, and H. H. Reese, in charge of work of this division at the experiment farm, Beltsville, Md.

THE BIOCHEMIC DIVISION.

M. Dorset, *Chief.*

This division prepares tuberculin and mallein and furnishes these substances free of charge to health officers for use in official tests. It conducts experiments concerning immunity, with the object of obtaining vaccines and antitoxins for animal diseases; carries on researches concerning causes of certain infectious diseases; in connection with the meat-inspection service makes bacteriological and chemical examinations of meats and meat food products and of condiments, etc., used in their preparation; carries on experiments with dips and disinfectants; and prepares for publication reports of work done.

The scientific work of the division is subdivided as follows: Hog-cholera investigations; investigations of dips and disinfectants; tuberculin and mallein laboratory; meat-inspection laboratories. There are seven meat-inspection laboratories, a central laboratory being located in Washington, and branch laboratories in six other cities.

The scientific staff of the division includes J. A. Emery, in charge of research work on meat products; T. M. Price, in charge of central meat-inspection laboratory; C. N. McBryde, in charge of bacteriological investigations of meats; R. M. Chapin, in charge of investigations of dips and disinfectants; and W. B. Niles, in charge of field experiments concerning hog cholera.

THE DAIRY DIVISION.

B. H. Rawl, *Chief.*

The work of this division is "to collect and disseminate information concerning dairy farming, the care and improvement of dairy cattle, and the production, care, and distribution of dairy products." It maintains a general survey of the condition of the dairy industry in the country at large and in the different sections, in addition to special inquiries as to dairy organizations, dairy schools and facilities for technical instruction, State dairy laws, the development of markets, the milk supply of cities and towns, and the laws and regulations in reference thereto.

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Investigations are conducted in dairy-farm management, including special work in the Southern and Western States for the introduction of better dairy practice and the encouragement of diversified farming through the introduction of dairying. The formation of cow-testing associations on a self-sustaining basis is receiving attention.

The division also makes investigations as to the manufacture of butter and cheese, including European varieties of cheese, and concerning dairy machinery and equipment. The division architect prepares plans and gives technical advice for the construction of sanitary and economical dairy buildings. The organization and management of creameries and factories and of the larger dairy enterprises, now increasing in number and importance, are receiving special attention. The division is also charged with the details of administration of the laws concerning the inspection of factories and markets for "renovated" or "process" butter.

Considerable attention has been given to work in connection with the improvement of city milk supplies. This is accomplished by means of cooperation with the local authorities. Public meetings are arranged wherein the producers, consumers, physicians, and others are brought together and the subject of milk improvement discussed. There is usually also a competitive exhibit of milk and cream, and sometimes of dairy farms. The score-card system of scoring dairies and farms used and recommended by the division is indispensable for this work. It has been found of great value in a large number of cities where it is now regularly in use.

Reports upon these lines of work are prepared and published, and an extensive correspondence is conducted to ascertain and meet the needs of those interested in the various departments of the dairy industry. The division seeks to serve as a clearing house for dairy experience and information. Its officers and agents visit the dairy centers and conventions for personal contact and advice.

The work of the dairy division is subdivided as follows: Dairy farming investigations, in charge of Helmer Rabild; research laboratories, in charge of L. A. Rogers; dairy manufacturing investigations, in charge of S. C. Thompson; market milk investigations, in charge of George M. Whitaker; renovated butter inspection, in charge of Robert McAdam.

THE INSPECTION DIVISION.

RICE P. STEDDOM, *Chief;* MORRIS WOODEN, R. A. RAMSAY, and ALBERT E. BEHNKE, *Associate Chiefs.*

The work of the Inspection Division consists of two main lines—the meat inspection and the field work for the control and eradication of contagious diseases.

The meat inspection includes the ante-mortem and post-mortem inspection of cattle, sheep, swine, and goats slaughtered at establishments engaged in interstate or foreign commerce; the supervision of such establishments and of the various processes of preparing, curing, canning, packing, etc., so as to insure sanitary conditions, equipment, and methods; the condemnation and proper disposal of carcasses and products found to be diseased, unwholesome, or otherwise unfit for human food; the marking and certification of meats and products that have been inspected and passed; and the regulation and supervision of the interstate transportation and exportation of meats and meat food products. The meat inspection is carried on at 863 establishments in 238 cities and towns.

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The field work consists in the inspection of live stock at points of origin, in transit, and at market centers, the disinfection of cars, and the supervision and enforcement of other measures to prevent the spread of contagious diseases through the channels of interstate commerce and to stamp out such diseases. This includes the eradication of southern cattle ticks, the inspection of southern cattle, and the supervision of their movement when forwarded from the area quarantined on account of Texas or southern cattle fever; also the inspection and, when necessary, the dipping of sheep and cattle to eradicate and prevent the spread of scabies. As a result of the latter work, in cooperation with State and Territorial authorities, sheep scab and cattle mange have been wiped out from large areas in the West where they were formerly prevalent, and efforts are being directed toward the ultimate eradication of these diseases from the United States.

THE PATHOLOGICAL DIVISION.

JOHN R. MOHLER, *Chief.*

The work of this division is chiefly along the lines of investigating diseases of animals. It prepares and distributes blackleg vaccine and tabulates the results; conducts scientific investigations of animal diseases; carries on experiments with immunizing agents for the purpose of protecting animals against diseases; cooperates with the State agricultural experiment stations with a view to combating diseases peculiar to the localities; determines pathological specimens referred to the division for diagnosis; and prepares answers to numerous inquiries regarding diseases of animals. Reports are prepared and published upon the experimental work carried on.

The scientific staff of the division includes Henry J. Washburn, senior bacteriologist; J. S. Buckley, in charge of rabies investigations; George Byron Morse, in charge of investigations concerning diseases of poultry and cold-blooded animals; Charles F. Flocken, in charge of cooperative experiments with the Minnesota Experiment Station; Adolph Eichhorn, in charge of glanders investigations; Robert J. Formad, assistant in animal pathology; Jacob Traum, in charge of field investigations; John M. Buck, assistant in animal bacteriology; H. C. Campbell, in charge of cooperative experiments with the Pennsylvania live-stock sanitary board; H. J. Frederick, in charge of cooperative experiments with Utah Experiment Station; L. Enos Day, in charge of branch pathological laboratory at Chicago, Ill.; and Charles F. Dawson, in charge of cooperative experiments with the Delaware Experiment Station.

THE QUARANTINE DIVISION.

RICHARD W. HICKMAN, *Chief.*

The inspection and quarantine of imported animals with a view to excluding contagion, the management of the animal quarantine stations, and the inspection of live stock for export come under this division. Ships carrying exported animals are inspected, and regulations as to fittings, equipment, ventilation, feed, water, attendants, etc., are enforced. It also carries on cooperative work with State and other authorities for the intrastate tuberculin testing of dairy and breeding cattle and of cows supplying milk to cities, with a view to elminінating tuberculosis from dairy herds and from among such breeding cattle.

THE ZOOLOGICAL DIVISION.

B. H. RANSOM, *Chief.*

This division investigates diseases of parasitic origin and prepares and publishes reports on such investigations, collects and describes animal parasites of all kinds, determines such parasites as are sent to the bureau for identifica-

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tion, and conducts correspondence regarding them; keeps a card index of animal parasites and a bibliography of literature relating to them. The scientific staff includes Albert Hassall, Harry W. Graybill, and Maurice C. Hall, assistant zoologists, and Howard Crawley and Winthrop D. Foster, junior zoologists.

THE EXPERIMENT STATION.

E. C. SCHROEDER, *Superintendent;* W. E. COTTON, *Assistant.*

The Experiment Station of the bureau is located at Bethesda, Md. It is equipped for and conducts investigations regarding animal diseases with a view to their control and eradication and their bearing on the public health, and investigations in animal breeding, with special reference to the laws of heredity and the development of increased resistance to disease. A small farm is maintained in such a manner as to provide the other divisions of the bureau with facilities for making observations for which large domestic animals are needed. The work of the station consists of independent original investigations and investigations in cooperation with and supplemental to those of the other divisions. Reports of the results obtained are written for publication.

THE EDITORIAL OFFICE.

JAMES M. PICKENS, *Editor.*

The work of this office comprises the editing and proof reading on behalf of the bureau, the compilation of the annual report, and the preparation of special articles and other material for publication. This office also makes translations, compiles information, and attends to miscellaneous correspondence.

PUBLICATIONS OF THE BUREAU IN 1910.

Following is a list of publications issued by the Bureau of Animal Industry during the year 1910, excepting regulations, which are to be found in this report (pages 532–556). A circular giving a list of the available publications of the bureau will be sent free upon request addressed to the Secretary of Agriculture. The editions of some of the publications are necessarily limited, and when the supply is exhausted and no funds are available for procuring additional copies applicants will be referred to the Superintendent of Documents, Government Printing Office, Washington, D. C., the officer designated by law to sell Government publications.

REPORTS.

Twenty-fifth Annual Report of the Bureau of Animal Industry for the year 1908. Pp. 502, pls. 11, figs. 72.

Report of the Chief of the Bureau of Animal Industry for [the fiscal year ended June 30,] 1910. Pp. 83.

BULLETINS.

Bulletin 39, Part 26. Index-Catalogue of Medical and Veterinary Zoology. Authors: S to Schnyder. Pp. 1981–2076.

Same, Part 27. Authors: Schoch to Silvestrini. Pp. 2077–2168.

Same, Part 28. Authors: Sim to von Stenitzer. Pp. 2169–2250.

Same, Part 29. Authors: Stenroos to Szymánski. Pp. 2251–2326.

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Same, Part 30. Authors: T to Thon. Pp. 2327–2386.

Same, Part 31. Authors: Thooris to Utz. Pp. 2387–2442.

Same, Part 32. Authors: V to Vyner. Pp. 2443–2508.

Bulletin 118. Cultural Studies of Species of *Penicillium*. By Charles Thom, mycologist in cheese investigations, Dairy Division. Pp. 109, figs. 36.

Bulletin 120. The Intracellular Enzyms of *Penicillium* and *Aspergillus*, with Special Reference to Those of *Penicillium camemberti*. By Arthur Wayland Dox, chemist in cheese investigations, Dairy Division. Pp. 70.

Bulletin 122. Factors Controlling the Moisture Content of Cheese Curds. By J. L. Sammis, of the Wisconsin Agricultural Experiment Station, and S. K. Suzuki, chemist, and W. F. Laabs, cheesemaker, of the Dairy Division, Bureau of Animal Industry. Pp. 61, figs. 27.

Bulletin 123. The Influence of Lactic Acid on the Quality of Cheese of the Cheddar Type. By C. F. Doane, assistant dairyman, Dairy Division. Pp. 20, figs. 2.

Bulletin 124. Methods and Standards in Bomb Calorimetry. Investigations in Cooperation with the Institute of Animal Nutrition of the Pennsylvania State College. By J. August Fries, assistant expert in animal nutrition. Pp. 32.

Bulletin 125, Part 1. The Gid Parasite and Allied Species of the Cestode Genus *Multiceps*. I. Historical Review. By Maurice C. Hall, junior zoologist, Zoological Division. Pp. 68, fig. 1.

Bulletin 126. The Bacteriology of Commercially Pasteurized and Raw Market Milk. By S. Henry Ayers, bacteriologist, Dairy Division, and William T. Johnson, scientific assistant, Dairy Division. Pp. 98, figs. 16.

CIRCULARS.

Circular 153. The Dissemination of Disease by Dairy Products. I. Milk as a Carrier of Contagious Disease, and the Desirability of Pasteurization. By G. Lloyd Magruder. II. The Importance of a Wholesome Milk Supply. By John R. Mohler. III. The Relation of the Tuberculous Cow to Public Health. By E. C. Schroeder. IV. Interpretation of Results of Bacteriological Examination of Milk. By L. A. Rogers and S. H. Ayers. V. Pasteurization, Its Advantages and Disadvantages. By M. J. Rosenau. Pp. 57, figs. 11.

Circular 154. The Need of State and Municipal Meat Inspection to Supplement Federal Inspection. By A. M. Farrington, Assistant Chief, Bureau of Animal Industry. Pp. 14, figs. 6. (Reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry.)

Circular 155. Mycotic Lymphangitis of Horses. By John R. Mohler, Chief of the Pathological Division. Pp. 5, figs. 4. (Reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry.)

Circular 156. Chronic Bacterial Dysentery of Cattle. By John R. Mohler, Chief of the Pathological Division. Pp. 3, fig. 1. (Reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry.)

Circular 157. The Prevention of Losses Among Sheep from Stomach Worms (*Hæmonchus contortus*). By B. H. Ransom, Chief of the Zoological Division. Pp. 10. (Reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry.)

Circular 158. Improved Methods for the Production of Market Milk by Ordinary Dairies. By C. B. Lane and Karl E. Parks, of the Dairy Division. Pp. 12, figs. 11. (Reprinted from the Twenty-fifth Annual Report of the Bureau of Animal Industry.)

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Circular 159. Some Important Facts in the Life History of the Gid Parasite and their Bearing on the Prevention of the Disease. By Maurice C. Hall, junior zoologist, Zoological Division. Pp. 7.

Circular 160. Lip-and-Leg Ulceration of Sheep. I. The Work of the Bureau of Animal Industry for the Suppression of Lip-and-Leg Ulceration of Sheep. By A. D. Melvin, Chief of the Bureau of Animal Industry. II. Lip-and-Leg Ulceration (Necrobacillosis) of Sheep: Its Cause and Treatment. By John R. Mohler, Chief of the Pathological Division. Pp. 35, figs. 7.

Circular 161. Whey Butter. By C. F. Doane, assistant dairyman, Dairy Division. Pp. 7.

Circular 162. Officials, Organizations, and Educational Institutions Connected with the Dairy Interests (1910). Pp. 31.

Circular 163. The Regeneration of the Morgan Horse. By George M. Rommel, Chief of the Animal Husbandry Division. Pp. 14, figs. 2.

Circular 164. State Live-Stock Sanitary Officers. Pp. 4.

Circular 165. Methods for the Eradication of Gid. By Maurice C. Hall, junior zoologist, Zoological Division. Pp. 29, pl. 1, figs. 14.

SEPARATES FROM TWENTY-FIFTH ANNUAL REPORT.

The Economic Importance of Tuberculosis of Food-Producing Animals. By A. D. Melvin, Chief of the Bureau of Animal Industry. Pp. 97–107.

The 1908 Outbreak of Foot-and-Mouth Disease in the United States. By A. D. Melvin, Chief of the Bureau of Animal Industry. Pp. 379–392, figs. 65–72.

The Causation and Character of Animal Tuberculosis, and Federal Measures for Its Repression. By John R. Mohler, Chief of the Pathological Division. Pp. 155–164.

Malta Fever and the Maltese Goat Importation. By John R. Mohler, Chief of the Pathological Division, and George H. Hart, Assistant in Bacteriology, Pathological Division. Pp. 279–295, Pl. V, figs. 36–38.

The Effect of Smelter Fumes upon the Live-Stock Industry in the Northwest. By Robert J. Formad, pathologist, Pathological Division. Pp. 237–268, figs. 29–35.

The Relation of the Tuberculous Cow to Public Health. By E. C. Schroeder, superintendent of the Bureau Experiment Station. Pp. 109–153, pls. I–III, figs. 7–21.

Notes on the Animal Industry of Argentina. By George M. Rommel, animal husbandman, Bureau of Animal Industry. Pp. 315–333, pls. VI–XI, figs. 39–53.

State Legislation Regulating the Standing of Stallions and Jacks for Public Service. By Roy A. Cave, herdbook assistant, Bureau of Animal Industry. Pp. 335–344.

The Action of Saltpeter Upon the Color of Meat. By Ralph Hoagland, in charge of Chicago laboratory, Biochemic Division. Pp. 301–314.

The Control of Hog Cholera by Serum Immunization. By A. D. Melvin, Chief of the Bureau of Animal Industry. Pp. 219–224.

Field Tests with Serum for the Prevention of Hog Cholera. By W. B. Niles, inspector in charge of field station, Biochemic Division. Pp. 177–217.

SEPARATE FROM DEPARTMENT YEARBOOK.

Tuberculosis of Hogs and How to Control It. By John R. Mohler, chief, Pathological Division, and Henry J. Washburn, senior bacteriologist, Pathological Division. Pp. 227–238, pls. 3.

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FARMERS' BULLETINS.

Farmers' Bulletin 380. The Loco-Weed Disease. By C. Dwight Marsh, expert, poisonous plant investigations, Bureau of Plant Industry. Pp. 16, figs. 4.

Farmers' Bulletin 411. Feeding Hogs in the South. By Dan T. Gray, professor of animal industry, Alabama Polytechnic Institute; expert in animal husbandry, Bureau of Animal Industry. Pp. 47, figs. 9.

Farmers' Bulletin 413. The Care of Milk and Its Use in the Home. By George M. Whitaker, in charge of market milk investigations, Dairy Division, Bureau of Animal Industry; L. A. Rogers, bacteriologist in charge of research laboratories, Dairy Division, Bureau of Animal Industry; and Caroline L. Hunt, expert in nutrition, Office of Experiment Stations. Pp. 20.

RULES AND REGULATIONS OF THE SECRETARY OF AGRICULTURE RELATING TO THE ANIMAL INDUSTRY ISSUED IN 1910.

AMENDMENT 12 TO B. A. I. ORDER 136.

Regulations for the Certification of Associations of Breeders of Purebred Live Stock and Books of Record of Pedigrees—Withdrawal of Certification.

U. S. DEPARTMENT OF AGRICULTURE, OFFICE OF THE SECRETARY,
Washington, D. C. April 21, 1910.

On account of the removal of the office of the following association and book of record of pedigrees to Canada, its certification has been withdrawn and the Secretary of the Treasury informed to this effect:

American books of record.

SHEEP.

Name of breed.	Book of record.	By whom published.
Suffolk............	American Suffolk Flock Record.	American Suffolk Flock Registry Association, George W. Franklin, secretary, Des Moines, Iowa.

JAMES WILSON, *Secretary.*

AMENDMENT 10 TO B. A. I. ORDER 142.

Amendment to Regulation 45 of Bureau of Animal Industry Order 142 (Regulations for the Inspection and Quarantine of Horses, Cattle, Sheep, and Other Ruminants, and Swine Imported into the United States), for the Purpose of Preventing the Importation from Mexico of Horses Infested with Ticks (Margaropus Annulatus) into any Area of the United States from which Cattle are Excluded on Account of Ticks.

U. S. DEPARTMENT OF AGRICULTURE, OFFICE OF THE SECRETARY,
Washington, D. C., June 1, 1910.

Regulation 45 of the Regulations of the Secretary of Agriculture for the Inspection and Quarantine of Horses, Cattle, Sheep, and Other Ruminants, and Swine Imported into the United States, Bureau of Animal Industry Order 142, is hereby amended to read as follows:

All horses infested with ticks are prohibited from entering the United States from the Republic of Mexico, when destined to an area in the United States from which cattle are excluded by the Federal, State, or Territorial authorities on account of ticks, unless and until such tick-infested horses are first dipped or otherwise treated as hereinafter specified in this regulation.

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Horses that can be handled and inspected for ticks shall be so inspected at the port of entry. The importation of unbroken horses (i. e., those which are not gentle and are not broken for saddle, harness, or work), destined to an area from which cattle are excluded by the Federal, State, or Territorial authorities on account of ticks, is prohibited unless the horses are first dipped as hereinafter specified in this regulation for tick-infested horses. However, if horses intended for importation into the United States are held for six months immediately preceding the date they are offered for importation, on premises known to be free from ticks, they may be admitted for any destination without dipping. Horses belonging to Indian tribes and settlers and those used in stock raising (cow ponies) or mining, and those for temporary stay at points along the frontier, not to exceed two weeks, whether for pleasure, driving, or teaming, may be admitted into the United States without inspection, provided they are not entered, moved, or permitted to enter into any portion of any State or Territory into which the movement of cattle is prohibited by the Federal, State, or Territorial authorities on account of ticks.

The dipping required for tick-infested horses shall be done in Beaumont crude petroleum or standard arsenical solution, or the horses shall be otherwise treated in a manner approved by the Secretary of Agriculture.

Horses will be admitted in bond at any port of the United States upon inspection for export from any port of the United States. They shall, however, be subject to inspection when exported from ports at which the department has inspectors stationed.

Horses.—This word, in this regulation, refers to and includes horses, mules, asses, and burros.

Ticks.—This word refers to cattle ticks (*Margaropus annulatus*).

Standard arsenical solution.—In preparing each 500 gallons of the standard arsenical solution there shall be used 10 pounds of finely powdered white arsenic containing not less than 99 per cent of arsenic trioxid, 25 pounds of sal soda, and 1 gallon of pine tar. The arsenic and sal soda shall be boiled together in not less than 25 gallons of water for 15 minutes, or longer if necessary to effect complete solution of the arsenic. Before the pine tar is added the temperature of the solution shall be reduced to 140° F. This may be done by the addition of cold water. The pine tar shall then be added in a small stream while the solution is thoroughly stirred, after which the solution shall be immediately diluted with clear water sufficient to make 500 gallons of dip.

This amendment shall become and be effective on and after July 1, 1910.

WILLIS L. MOORE, *Acting Secretary of Agriculture.*

AMENDMENT 8 TO B. A. I. ORDER 146.

Amendment 8 to Rule 3, Revision 1.—To Prevent the Spread of Scabies in Sheep (effective on and after August 29, 1910).

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

It is ordered that the quarantine for scabies in sheep placed upon the State of Kentucky by amendment 4 to rule 3, revision 1, dated August 5, 1909, and effective on and after August 16, 1909, be, and the same is hereby, modified to permit the interstate shipment of sheep of States not quarantined for scabies in sheep which are exhibited at the Kentucky State Fair to be held at Louisville September 13 to 18, 1910, inclusive, subject to the following restrictions:

(*a*) Such sheep shall be shipped by rail to Louisville and shall not be unloaded in the area quarantined for sheep scabies elsewhere than at Louisville.

(*b*) Separate cleaned and disinfected chutes and other facilities shall be provided for the exclusive unloading and loading of such sheep at Louisville.

(*c*) Such sheep shall be hauled in cleaned and disinfected wagons direct from the cars in which they arrive at Louisville to the fair grounds, and from the fair grounds direct to the cars in which they are to be reshipped.

(*d*) That portion of the fair grounds or other premises to be occupied exclusively by such sheep shall be cleaned and disinfected under the supervision of an employee of the Bureau of Animal Industry before said sheep are placed therein.

(*e*) Such sheep shall not be moved interstate from Louisville except in cleaned and disinfected cars, nor unless accompanied by a certificate issued by an inspector of the Bureau of Animal Industry showing that the sheep have had no opportunity to become infected with scabies.

Done at Washington this 18th day of August, 1910.

Witness my hand and seal of the Department of Agriculture.

[SEAL.] W. M. HAYS, *Acting Secretary of Agriculture.*

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B. A. I. ORDER 167.

Rule 2, Revision 3.—To Prevent the Spread of Scabies in Cattle (effective on and after January 15, 1910).

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

The fact has been determined by the Secretary of Agriculture, and notice is hereby given, that a contagious, communicable disease known as scabies exists among cattle in the following-named States and Territory, to wit:

MONTANA, SOUTH DAKOTA, NEBRASKA, KANSAS, WYOMING, COLORADO, OKLAHOMA, TEXAS, AND NEW MEXICO.

Now, therefore, I, JAMES WILSON, SECRETARY OF AGRICULTURE, under authority conferred by section 1 of the act of Congress approved March 3, 1905 (33 Stat., 864), do hereby quarantine the following territory, to wit:

In MONTANA the counties of Teton, Chouteau, Valley, and Dawson.

In SOUTH DAKOTA all that territory lying south and west of the Missouri River.

In NEBRASKA the counties of Sioux, Scotts Bluff, Banner, Kimball, Cheyenne, Boxbutte, Dawes, Sheridan, Deuel, Dundy, Chase, Perkins, Keith, McPherson, Grant, Cherry, Hooker, Thomas, Logan, Lincoln, Hayes, Hitchcock, Blaine, Brown, Keyapaha, Rock, Loup, Garfield, Wheeler, and Holt.

In KANSAS the counties of Wallace, Greeley, Hamilton, Stanton, Morton, Stevens, Grant, Kearney, Wichita, Scott, Finney, Gray, Haskell, Seward, Meade, and Clark.

In WYOMING the counties of Natrona, Converse, and Laramie.

In COLORADO the counties of Logan, Sedgwick, Phillips, Yuma, Washington, Morgan, Kit Carson, Cheyenne, Kiowa, Prowers, Baca, Bent, Otero; that part of the counties of Pueblo, Huerfano, and Las Animas lying east of the eighth guide meridian west; that part of the counties of Weld and Adams lying east of the Union Pacific Railroad from its intersection with the Colorado-Wyoming State line, southerly to its intersection with the northern boundary of Denver County; that part of Adams, Arapahoe, Elbert, and Lincoln Counties lying north and east of the Union Pacific Railroad from its intersection with the eastern boundary of Denver County, southeasterly to Limon, Colo., and that part of Lincoln, Elbert, and El Paso Counties lying south and east of the Chicago, Rock Island & Pacific Railway from Limon, Colo., southwesterly to its intersection with the eighth guide meridian west.

In OKLAHOMA the countries of Cimarron, Texas, Beaver, and Harper.

In TEXAS the counties of Dallam, Sherman, Hansford, Ochiltree, Lipscomb, Hemphill, Roberts, Hutchinson, Moore, Hartley, Oldham, Potter, Carson, Gray, Donley, Armstrong, Randall, Deaf Smith, Parmer, Castro, Swisher, Briscoe, Hall, Motley, Floyd, Hale, Lamb, Bailey, Cochran, Hockley, Lubbock, Crosby, Dickens, Kent, Garza, Lynn, Terry, Yoakum, Gaines, Dawson, Borden, Scurry, Howard, Martin, Andrews, Nueces, Cameron, and Hidalgo.

In NEW MEXICO the counties of Union, Guadalupe, Quay, Roosevelt, Chaves, Eddy, that portion of Torrance County lying east and south of the El Paso & Rock Island Railway, that portion of Lincoln County lying east and south of the El Paso & Northeastern and the El Paso & Rock Island Railways, and that portion of Otero County lying east of the El Paso & Northeastern Railway.

The effect of this order is to release from quarantine the counties of Boyd, Custer, and Dawson, in the State of Nebraska; the counties of Cheyenne, Rawlins, Sherman, Logan, Gove, Lane, Ford, Kiowa, and Comanche, in the State of Kansas; the counties of Carbon and Albany, in the State of Wyoming; that part of Weld and Adams counties lying west of the Union Pacific Railroad running from Denver to Cheyenne; that part of the counties of Adams, Arapahoe, Elbert, Lincoln, and El Paso lying south and west of the Union Pacific Railroad running southeasterly from Denver to Limon and north and west of the Chicago, Rick Island & Pacific Railway running southwesterly from Limon, Colo., to its intersection with the eighth guide meridian west, in the State of Colorado, and the counties of Wheeler, Collingsworth, Childress, Cottle, King, Stonewall, Fisher, Nolan, Mitchell, and that part of Knox, Haskell, Jones, and Taylor Counties lying west of the one hundredth meridian west of Greenwich, in the State of Texas.

It is ordered by this rule 2, revision 3, under the authority and discretion conferred upon the Secretary of Agriculture by section 3 of the act of Congress approved March 3, 1905 (33 Stat., 864), that cattle shall be moved from the quarantined area of any State or Territory to any other State or Territory or District only in accordance with the regulations of the Secretary of Agriculture designated as B. A. I. Order 143, promulgated March 22, 1907, and effective April 15, 1907, and the amendments thereto.

This rule 2, revision 3, is subject to amendment or revision on statutory notice.

Rule 2, revision 2, dated September 5, 1908, and effective October 1, 1908, and its amendments dated September 23, 1908, May 6, 1909, and August 19, 1909, respectively,

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shall cease to be effective on and after January 15, 1910, on and after which date this rule 2, revision 3, which for purposes of identification is designated as B. A. I. Order 167, shall become and be effective until otherwise ordered.

Done at Washington this 22d day of December, 1909.

Witness my hand and the seal of the Department of Agriculture.

[SEAL.] JAMES WILSON, *Secretary of Agriculture.*

AMENDMENT 1 TO B. A. I. ORDER 167.

Amendment 1 to Rule 2, Revision 3.—To Prevent the Spread of Scabies in Cattle (effective on and after August 1, 1910).

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

The fact has been determined by the Acting Secretary of Agriculture, and notice is hereby given, that the contagious disease known as scabies is not now known to exist, or exists to a slight extent only, among cattle in the county of Dawson, in the State of Montana, and in the counties of Hayes, Hitchcock, Chase, and Dundy, in the State of Nebraska, quarantined by rule 2, revision 3, dated December 22, 1909, and effective January 15, 1910.

Now, therefore, I, WILLIS L. MOORE, ACTING SECRETARY OF AGRICULTURE, under authority of law, do hereby amend said rule 2, revision 3, to prevent the spread of scabies in cattle, in the following particulars, to wit:

That part of said rule which specifies the quarantined portion of the State of Montana is amended to read as follows:

In MONTANA the counties of Teton, Chouteau, and Valley.

That part of said rule which specifies the quarantined portion of the State of Nebraska is amended to read as follows:

In NEBRASKA the counties of Sioux, Scotts Bluff, Banner, Kimball, Cheyenne, Boxbutte, Dawes, Sheridan, Deuel, Perkins, Keith, McPherson, Grant, Cherry, Hooker, Thomas, Logan, Lincoln, Blaine, Brown, Keyapaha, Rock, Loup, Garfield, Wheeler, Holt, and Morrill.

The effect of this order is to release from quarantine on account of scabies in cattle the county of Dawson, in the State of Montana, and the counties of Hayes, Hitchcock, Chase, and Dundy, in the State of Nebraska.

Done at Washington this 21st day of July, 1910.

Witness my hand and the seal of the Department of Agriculture.

[SEAL.] WILLIS L. MOORE, *Acting Secretary of Agriculture.*

B. A. I. ORDER 168.

Rule 1, Revision 6.—To Prevent the Spread of Splenetic Fever in Cattle (effective on and after April 1, 1910).

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

The fact has been determined by the Secretary of Agriculture, and notice is hereby given, that a contagious and infectious disease known as splenetic, southern, or Texas fever exists among cattle in the following-named States, to wit:

CALIFORNIA, OKLAHOMA, TEXAS, MISSOURI, ARKANSAS, LOUISIANA, MISSISSIPPI, TENNESSEE, ALABAMA, VIRGINIA, NORTH CAROLINA, SOUTH CAROLINA, GEORGIA, AND FLORIDA.

Now, therefore, I, JAMES WILSON, SECRETARY OF AGRICULTURE, under authority conferred by section 1 of the act of Congress approved March 3, 1905 (33 Stat., 1264), do hereby quarantine the area hereinafter described, and do order by this rule 1, revision 6, under the authority and discretion conferred on the Secretary of Agriculture by section 3 of the act of Congress approved March 3, 1905 (33 Stat., 1265), that the interstate movement of cattle of the area herein quarantined to any point not located in the said quarantined area shall be made only in accordance with the regulations of the Secretary of Agriculture designated as B. A. I. Order 143, promulgated March 22, 1907, and effective April 15, 1907, and amendments thereto, subject only to the exceptions hereinafter contained.

The following areas are quarantined for splenetic, southern, or Texas fever in cattle:

CALIFORNIA.

The counties of San Diego, Orange, Santa Barbara County with the exception of the island of Santa Rosa, and that portion of San Luis Obispo County located south and

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west of a line beginning at the point of the intersection of the township line between township 32 south, range 17 east, and township 32 south, range 18 east, with the Santa Maria River on the southern boundary of the county of San Luis Obispo, and extending northerly on said township line between township 32 south, range 17 east, and township 32 south, range 18 east, and on township line between township 31 south, range 17 east, and township 31 south, range 18 east, to its intersection with the summit of the Santa Lucia range of mountains; thence following the summit of the Santa Lucia range of mountains northwesterly to its intersection with the northern boundary line of San Luis Obispo County.

During the continuance of this quarantine no cattle of the area hereinbefore described shall be moved or allowed to move except as provided for immediate slaughter to any point in the United States not in the State of California which is located in an area not quarantined for splenetic, southern, or Texas fever unless and until the said cattle shall have been continuously kept on premises known to have been free of infection for at least six months and unless and until the cattle shall have been inspected and found free of infection and a certificate authorizing the shipment issued by an inspector of the Bureau of Animal Industry, nor until permission shall have been obtained in advance of the movement from the proper official of the State or Territory into which the cattle are to be shipped.

TEXAS.

The entire State of Texas is quarantined, with the exception of the counties of Dallam, Sherman, Hansford, Ochiltree, Lipscomb, Hartley, Moore, Hutchinson, Roberts, Hemphill, Oldham, Potter, Carson, Gray, Wheeler, Deaf Smith, Randall, Armstrong, Donley, Collingsworth, Parmer, Castro, Swisher, Briscoe, Hall, Childress, Bailey, Lamb, Hale, Floyd, Motley, Cochran, Hockley, Lubbock, Crosby, Dickens, Yoakum, Terry, Lynn, Garza, Kent, Gaines, Dawson, Andrews, Martin, El Paso, Jeff Davis, Presidio, Brewster, Reeves, Loving, Winkler, Ector, Midland, Ward, Scurry, Borden, Glasscock, Crane, Upton, and those portions of the counties of Pecos and Terrell north and west of a line beginning at the southwest corner of Terrell County; thence in a northerly direction to the northwest corner of section No. 63, block D10, Texas Central Railway Co.; thence north along the western boundary of sections Nos. 64, 65, 66, 67, 68, 69, 70, 71, and 72 of said block D10 to the northwest corner of said section No. 72; thence continuing north through the western parts of sections Nos. 36, 25, 24, 13, 12, and 1, block 150, Texas & St. Louis Railroad Co., to the roadbed of the Galveston, Harrisburg & San Antonio Railroad Co.; thence southeasterly, following the roadbed of the said Galveston, Harrisburg & San Antonio Railroad Co., to a point on section No. 36, Block A2, Galveston, Harrisburg & San Antonio Railroad Co.; thence north with the pasture fence through the eastern part of sections Nos. 36, 13, and 12 of said block A2, and across section No. 1, Gulf, Colorado & Santa Fe Railway Co.; thence continuing north with said pasture fence through the eastern part of sections Nos. 16, 17, 46, 47, 76, 77, 106, 107, 136, 137, 142, 143, and 194, block D, Missouri, Kansas & Texas Extension Railway Co.; thence continuing in a northerly direction to a point on the northern boundary of section No. 6, block 160, Gulf, Colorado & Santa Fe Railway Co., same being corner of pasture fence; thence east along the northern boundary of sections Nos. 6, 9, 10, 11, 12, 15, and 16, block 160, Gulf, Colorado & Santa Fe Railway Co., to the northeast corner of said section No. 16, the same being corner of pasture fence; thence in a northerly direction with the eastern boundary of sections Nos. 22, 21, 20, 23, 24, 25, 26, 27, 28, 29, 30, 31, and 32, block 1, Corpus Christi, San Diego & Rio Grande Narrow Gauge Railway Co., to the northeast corner of said section No. 32; thence west with the northern boundary of sections Nos. 32 and 33, same block, to the northwest corner of section No. 33, block 1, Corpus Christi, San Diego & Rio Grande Narrow Gauge Railway Co., corner of fence; thence north with the eastern boundary of sections Nos. 1, 12, 13, 24, 25, 36, 37, 48, 49, 60, 61, and 72, block 2, Corpus Christi, San Diego & Rio Grande Narrow Gauge Railway Co., to the northeast corner of said section No. 72; thence in an easterly direction with the pasture fence to the southeast corner of section No. 9, patented to James E. Evans; thence north along the eastern boundary of said section No. 9 to the northwest corner of section No. 100, block A2, Texas Central Railway Co.; thence east with the northern boundary of sections Nos. 100 and 89, same block, to the northeast corner of said section No. 89, block A2, Texas Central Railway Co.; thence north along the eastern boundary of sections Nos. 90, 91, 92, and 93 to the southeast corner of section No. 94, block A2, Texas Central Railway Co.; thence northwest diagonally across section No. 94 to the northwest corner of said section; thence continuing in a northwesterly direction diagonally across sections Nos. 14, 18, and 28 to the northeast corner of section No. 29, block C4, Gulf, Colorado & Santa Fe Railway Co.; thence west with the northern boundary of said section No. 29 to the northwest corner of said section; thence northwest diagonally across section No. 1, Texas Central Railway Co., and section No. 97,

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block 194, Gulf, Colorado & Santa Fe Railway Co., to the northeast corner of section No. 96; thence in a northerly direction across section No. 94 to a point on its northern boundary 600 varas west of its northeast corner; thence continuing north through sections Nos. 93, 90, 89, 86, 85, and 58, block 194, Gulf, Colorado & Santa Fe Railway Co., to a point on the northern boundary of said section No. 58; thence northwesterly with the pasture fence through section No. 59 to the northeast corner of section No. 82 and the southeast corner of section No. 81, same block; thence continuing northwesterly to section No. 17, Houston & Great Northern Railroad Co.; thence north along the eastern boundary of said section No. 17 to the Pecos River; thence northwesterly along said Pecos River to the northwest corner of Crockett County.

During the continuance of this quarantine no cattle of the counties of Cottle, King, Stonewall, Fisher, Jones, Howard, Mitchell, Reagan, or of those portions of the counties of Hardeman, Knox, Foard, and Haskell west of the Kansas City, Mexico & Orient Railway, shall be moved or allowed to move, except as provided for immediate slaughter, to any point in the United States not in the State of Texas which is located in an area not quarantined for splenetic, southern, or Texas fever unless and until the said cattle shall have been continuously kept on premises known to have been free of infection for at least six months, and unless and until the cattle shall have been inspected and found free of infection and a certificate authorizing the shipment issued by an inspector of the Bureau of Animal Industry, nor until permission shall have been obtained in advance of the movement from the proper official of the State or Territory into which the cattle are to be shipped. Each application for inspection shall be duly made by the owner or the manager of the cattle on blank forms furnished by the department, and should be placed in the hands of the inspector of the Bureau of Animal Industry in charge of the district not less than 10 days in advance of the date on which inspection is required. Such applications for inspection shall be accompanied by affidavits when required by the said inspector.

From the other counties and portions of counties in that part of Texas which is quarantined for splenetic, southern, or Texas fever, cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

OKLAHOMA.

The entire State of Oklahoma is quarantined, except the counties of Cimarron, Texas, Beaver, Harper, Woods, Alfalfa, Grant, Woodward, Major, Garfield, Ellis, Dewey, Blaine, Kingfisher, Logan, Roger Mills, Custer, Beckham, Washita, Oklahoma, Harmon, Canadian, that portion of Cleveland County north of the line between townships 7 and 8 north, that portion of Noble County not included in townships 22 and 23 north, range 2 east, and that part of townships 22 and 23 north, range 1 east, which is east of the Atchison, Topeka & Santa Fe Railway, that portion of Kay County west of the Arkansas River, that portion of Caddo County north of the Mangum branch of the Chicago, Rock Island & Pacific Railway, those portions of Greer and Jackson Counties west of the Kansas City, Mexico & Orient Railway, and that portion of Payne County west and north of a line commencing at the northeast corner of township 20 north, range 4 east, Indian meridian; thence south to line between townships 19 and 20 north; thence west to line between ranges 3 and 4 east, Indian meridian; thence south to line between townships 18 and 19 north; thence west to line between ranges 2 and 3 east, Indian meridian; thence south to line between townships 17 and 18 north; thence west to line between ranges 1 and 2 east, Indian meridian; thence south to the northwest corner of Lincoln County.

During the continuance of this quarantine no cattle of those portions of Greer and Jackson Counties east of the Kansas City, Mexico, & Orient Railway, that portion of Cleveland County south of the line between townships 7 and 8 north and west of the Indian meridian, that portion of Caddo County south of the Mangum branch of the Chicago, Rock Island & Pacific Railway, and that portion of Lincoln County west and south of a line beginning at the intersection of the Atchison, Topeka & Santa Fe Railway with the southern boundary line of Lincoln County; thence following said railway in a northeasterly direction to its intersection with the Fort Smith & Western Railroad; thence following the said Fort Smith & Western Railroad in a northwesterly direction to its intersection with the Atchison, Topeka & Santa Fe Railway; thence westerly following the said Atchison, Topeka & Santa Fe Railway to its intersection with the western boundary line of Lincoln County, shall be moved or allowed to move, except as provided for immediate slaughter, to any point in the United States not in the State of Oklahoma which is located in an area not quarantined for splenetic, southern, or Texas fever unless and until the said cattle shall have been continuously kept on premises known to have been free of infection for at least six months and unless and until the cattle shall have been inspected and found free of infection and a certificate authorizing the shipment issued by an inspector of the Bureau of Animal Industry, nor until permission shall have been obtained in advance of the movement from the proper official of the State or Territory

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into which the cattle are to be shipped. Each application for inspection shall be duly made by the owner or the manager of the cattle on blank forms furnished by the department, and should be placed in the hands of the inspector of the Bureau of Animal Industry in charge of the district not less than 10 days in advance of the date on which inspection is required. Such applications for inspection shall be accompanied by affidavits when required by the said inspector.

From the other counties and portions of counties in that part of Oklahoma which is quarantined for splenetic, southern, or Texas fever cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

MISSOURI.

Ripley County, that portion of Oregon County south of the line between townships 22 and 23 north, that portion of Newton County west of the right of way of the Kansas City Southern Railway, and that portion of McDonald County west of the right of way of the Kansas City Southern Railway are quarantined.

During the continuance of this quarantine no cattle of those portions of Oregon, Newton, and McDonald Counties hereinbefore described shall be moved or allowed to move, except as provided for immediate slaughter, to any point in the United States not in the State of Missouri which is located in an area not quarantined for splenetic, southern, or Texas fever unless and until the said cattle shall have been continuously kept on premises known to have been free of infection for at least six months and unless and until the cattle shall have been inspected and found free of infection and a certificate authorizing the shipment issued by an inspector of the Bureau of Animal Industry, nor until permission shall have been obtained in advance of the movement from the proper official of the State or Territory into which the cattle are to be shipped.

From Ripley County cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

ARKANSAS.

The entire State of Arkansas is quarantined, except the counties of Carroll, Randolph, Clay, Greene, Lawrence, Craighead, Mississippi, Poinsett, Benton, and Washington.

During the continuance of this quarantine no cattle of that portion of Fulton County east of Spring River, or that portion of Sharp County north of Strawberry River, shall be moved or allowed to move, except as provided for immediate slaughter, to any point in the United States not in the State of Arkansas which is located in an area not quarantined for splenetic, southern, or Texas fever, unless and until the said cattle shall have been continuously kept on premises known to have been free of infection for at least six months, and unless and until the cattle shall have been inspected and found free of infection and a certificate authorizing the shipment issued by an inspector of the Bureau of Animal Industry, nor until permission shall have been obtained in advance of the movement from the proper official of the State or Territory into which the cattle are to be shipped.

From the other counties and parts of counties in that portion of the State of Arkansas which is quarantined for splenetic, southern, or Texas fever, cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

MISSISSIPPI.

The entire State of Mississippi is quarantined, except the counties of De Soto, Tate, and Tunica.

From the other counties in that part of the State of Mississippi which is quarantined for splenetic, southern, or Texas fever, cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

TENNESSEE.

The following-mentioned counties and parts of counties are quarantined: The counties of Hardeman, McNairy, Chester, Henderson, Decatur, Hardin, Wayne, Lawrence, Hamilton, Polk, Overton, that portion of Madison County east and south of a line beginning at a point on the southern boundary line of Madison County where the Illinois Central Railroad intersects said line, thence northerly along the Illinois Central Railroad to the south fork of Forked Deer River, thence easterly along said river to the mouth of Warlick Creek, thence northerly along said creek to its intersection with the Jackson and Cotton Grove Road, thence northerly along said road and the Cotton Grove Road and Spring Creek Road to Spring Creek, thence northeasterly along the Jackson and Spring Creek Road to the southern boundary of Carroll County; that portion of Benton County south of the Louisville & Nashville Railroad; that portion of Lincoln County south of

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Elk River; that portion of Marion County south and east of the Tennessee River; and that portion of Fentress County west of the east fork of Obey River.

During the continuance of this quarantine no cattle of Overton County, or that portion of Fentress County hereinbefore described, shall be moved or allowed to move, except as provided for immediate slaughter, to any point in the United States not in the State of Tennessee which is located in an area not quarantined for splenetic, southern, or Texas fever unless and until the said cattle shall have been continuously kept on premises known to have been free of infection for at least six months and unless and until the cattle shall have been inspected and found free of infection and a certificate authorizing the shipment issued by an inspector of the Bureau of Animal Industry, nor until permission shall have been obtained in advance of the movement from the proper official of the State or Territory into which the cattle are to be shipped.

From the other counties and portions of counties in that part of the State of Tennessee which is quarantined for splenetic, southern, or Texas fever, cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

GEORGIA.

The entire State of Georgia is quarantined except the counties of Union, Towns, Rabun, White, Habersham, and Stephens.

From the other counties in that part of the State of Georgia which is quarantined for splenetic, southern, or Texas fever, cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

SOUTH CAROLINA.

The entire State of South Carolina is quarantined except the counties of Oconee, Pickens, Greenville, and Anderson.

From the other counties in the State of South Carolina cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

NORTH CAROLINA.

The counties of Franklin, Wake, Chatham, Randolph, Stanly, Montgomery, Moore, Lee, Harnett, Johnston, Wilson, Nash, Halifax, Northampton, Hertford, Bertie, Gates, Chowan, Perquimans, Pasquotank, Camden, Currituck, Edgecomb, Martin, Washington, Tyrrell, Dare, Hyde, Beaufort, Pitt, Wayne, Sampson, Cumberland, Richmond, Scotland, Robeson, Bladen, Greene, Lenoir, Craven, Pamlico, Carteret, Jones, Duplin, Onslow, Pender, Columbus, Brunswick, and New Hanover are quarantined.

From the counties above mentioned cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

VIRGINIA.

The counties of Fluvanna, Chesterfield, Greenesville, Sussex, Surry, Southampton, Isle of Wight, Nansemond, and that part of Warwick County not included in the Newport News magisterial district, and that part of York County not included in the Bruton magisterial district, are quarantined.

From the counties and parts of counties above mentioned cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

LOUISIANA.

The entire State of Louisiana is quarantined.

During the continuance of this quarantine no cattle of the parishes of Lincoln and Claiborne shall be moved or allowed to move, except as provided for immediate slaughter, to any point in the United States not in the State of Louisiana which is located in an area not quarantined for splenetic, southern, or Texas fever, unless and until the said cattle shall have been continuously kept on premises known to have been free of infection for at least six months and unless and until the cattle shall have been inspected and found free of infection and a certificate authorizing the shipment issued by an inspector of the Bureau of Animal Industry, nor until permission shall have been obtained in advance of the movement from the proper official of the State or Territory into which the cattle are to be shipped.

From the other parishes in the State of Louisiana cattle shall only be moved or allowed to move interstate to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

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ALABAMA, FLORIDA.

The entire States of Alabama and Florida are quarantined.

From the above-mentioned States cattle shall only be moved or allowed to move to points outside of the quarantined area in accordance with the regulations for immediate slaughter.

GENERAL PROVISIONS.

During the continuance of the quarantine as herein established no cattle of the quarantined area of any State (except those portions from which cattle may be moved upon inspection) shall be moved or allowed to move to any portion of the quarantined area of another State from which, under the specific provisions of this rule, cattle are allowed to be shipped for purposes other than immediate slaughter upon inspection and certification by an inspector of the Bureau of Animal Industry.

OPEN SEASON.

During the months of January, November, and December of each year cattle of the quarantined area of any State may be moved interstate therefrom for purposes other than immediate slaughter into the State of Kansas, the Territories of Arizona and New Mexico, those portions of the States of California and Texas not included in the quarantined area, and that portion of the State of Missouri south of the Missouri River if the said cattle shall have been continuously kept on premises known to have been free of infection for at least six months and shall first have been inspected under proper facilities for inspection at the point of origin and found free of infection and a certificate authorizing the movement issued by an inspector of the Bureau of Animal Industry, and if permission shall first have been obtained from the proper official of the State or Territory to which the cattle are destined.

During the period from November 15 of each year to January 31 of the following year cattle of the quarantined area of any State may be moved interstate therefrom for purposes other than immediate slaughter under the above-mentioned restrictions into that portion of the State of Arkansas not included in the quarantined area.

During the months of January and February, the first 15 days of March, and the last 16 days of December in each year cattle of the quarantined area of any State may be moved interstate therefrom for purposes other than immediate slaughter under the above-mentioned restrictions into those portions of the States of Virginia, North Carolina, and South Carolina not included in the quarantined area.

During the month of January and the last 17 days of December in each year cattle of the quarantined area of any State may be moved interstate therefrom for purposes other than immediate slaughter under the above-mentioned restrictions into that portion of the State of Oklahoma not included in the quarantined area.

Cattle of the quarantined area that have been shipped interstate during the months of January, November, and December of each year to any State or Territory outside of the quarantined area other than those States or Territories and portions thereof set out herein shall not be moved into any of the States or Territories or portions thereof hereinbefore mentioned within three months of the date of the movement from the quarantined area.

Cattle which are moved interstate from the quarantined area of any State into those States or Territories or portions thereof hereinbefore mentioned, under certificates from inspectors of the Bureau of Animal Industry, for feeding or stocking purposes, shall, when shipped, be transported in cleaned and disinfected cars or boats, and shall not be placed in stock pens which have been reserved for cattle originating in the quarantined area.

FEEDING STATIONS FOR NONINFECTED CATTLE.

Cattle not of the quarantined area which are transported interstate by rail through the quarantined area may be unloaded therein for rest, feed, and water into properly equipped noninfectious pens set apart for such cattle at the Fort Worth stock yards, at Fort Worth, Tex.; the stock yards of the Missouri, Kansas & Texas Railway at Hodge and Denison, Tex.; the stock yards of the International & Great Northern Railroad at Laredo, Tex.; the stock yards of the St. Louis & San Francisco Railroad at Sapulpa, Okla.; the stock yards of the Missouri, Kansas & Texas Railway at Muskogee, Okla.; the stock yards of the Kansas City, Mexico & Orient Railway at Altus, Okla.; and at such other points as may from time to time be authorized by the Secretary of Agriculture, provided such pens and the platforms, chutes, and alleyways leading thereto have been cleaned and disinfected under the supervision of an employee of the Bureau of Animal Industry and are constructed and maintained in accordance with the specifications set out in the regulations of the Secretary of Agriculture to prevent the spread of splenetic fever in cattle.

All cattle handled in such noninfectious pens shall be free from ticks (*Margaropus annulatus*) and shall not have been unloaded at any point in the quarantined area other

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than the designated unloading points named herein or hereafter authorized by the Secretary of Agriculture, and they shall be reloaded into the same cars from which unloaded or into other cars which have been cleaned, washed, and disinfected, as required by B. A. I. Order 143 and amendments thereto, immediately before loading therein, and reshipped as uninfected cattle.

ARSENICAL SOLUTION.

In accordance with the provisions of regulation 17 of the Regulations of the Secretary of Agriculture governing the inspection, disinfection, certification, treatment, handling, and method and manner of delivery and shipment of live stock which is the subject of interstate commerce, cattle of the area quarantined on account of Texas or splenetic fever or other cattle infested with or exposed to ticks (*Margaropus annulatus*) may be dipped, under the supervision of an inspector of the Bureau of Animal Industry, in the standard arsenical solution, and when properly certified by said inspector to be free of infection may be shipped interstate for purposes other than immediate slaughter, subject only to such restrictions as may be imposed by the authorities at destination: *Provided,* That such cattle shall be dipped twice, with an interval of from 7 to 10 days between the first and second dippings; that the cattle shall be considered infectious and shall be handled as such during the interval between dippings; that the cattle shall not be exposed to infection after the second dipping; and that the facilities for preparing the dip and dipping the cattle shall first have been approved by the Chief of the Bureau of Animal Industry.

In preparing each 500 gallons of the standard arsenical solution there shall be used 10 pounds of finely powdered white arsenic containing not less than 99 per cent of arsenic trioxid, 25 pounds of sal soda, and 1 gallon of pine tar. The arsenic and sal soda shall be boiled together in not less than 25 gallons of water for 15 minutes, or longer if necessary to effect complete solution of the arsenic. Before the pine tar is added the temperature of the solution shall be reduced to 140° F. This may be done by the addition of cold water. The pine tar shall then be added in a small stream while the solution is thoroughly stirred, after which the solution shall be immediately diluted with clear water sufficient to make 500 gallons of dip.

INTERPRETATION.

This rule 1, revision 6, shall be construed in connection with the regulations of the Secretary of Agriculture promulgated March 22, 1907, and effective on and after April 15, 1907, and amendments thereto, and is subject to amendment or revision on statutory notice.

Rule 1, revision 5, dated December 2, 1909, effective December 6, 1909, shall cease to be effective on and after April 1, 1910, on and after which date this rule 1, revision 6, which for purposes of identification is designated as B. A. I. Order 168, shall become and be effective until otherwise ordered.

The effect of this order is as follows:

In California the counties of Fresno, Tulare, Ventura, Los Angeles, San Bernardino, Riverside, and a portion of San Luis Obispo County are released from quarantine.

In Texas the counties of Borden, Glasscock, Upton, Crane, and portions of the counties of Pecos and Terrell are released from quarantine. Privilege for movement on inspection from the counties of Wilbarger, Baylor, and portions of the counties of Hardeman, Foard, Knox, and Haskell is revoked.

In Oklahoma portions of the counties of Noble, Payne, Cleveland, and Jackson are released from quarantine. Privilege for movement on inspection is provided for portions of the counties of Lincoln, Cleveland, Caddo, and Jackson, and revoked from a portion of Kay County.

In Arkansas the counties of Benton and Washington are released from quarantine.

In Mississippi the counties of De Soto, Tate, and Tunica are released from quarantine.

In Tennessee the counties of Bradley and James are released from quarantine.

In Georgia the counties of White, Habersham, and Stephens are released from quarantine.

In Virginia Brunswick County is released from quarantine.

Arsenical solution is officially recognized for dipping southern cattle.

Done at Washington this 12th day of March, 1910.

Witness my hand and the seal of the Department of Agriculture.

[SEAL.] JAMES WILSON, *Secretary of Agriculture.*

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AMENDMENT 1 TO B. A. I. ORDER 168.

Amendment 1 to Rule 1, Revision 6.—To Prevent the Spread of Splenetic Fever in Cattle. Amendment Regarding the Return of Cattle of the Nonquarantined Area that are Exhibited at the North Carolina State Fair at Raleigh, N. C., October 17 to 22, 1910.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

It is ordered that that portion of rule 1, revision 6, to prevent the spread of splenetic fever in cattle, effective on and after April 1, 1910, which relates to the quarantine in the State of North Carolina, is hereby modified to permit the interstate shipment to points outside the quarantined area as uninfected cattle, of cattle of the nonquarantined area that are exhibited at the North Carolina State Fair, to be held at Raleigh, N. C., October 17 to 22, 1910, subject to the following restrictions:

(*a*) Such cattle shall be shipped by rail to Raleigh and shall not be unloaded in the quarantined area elsewhere than at Raleigh.

(*b*) Separate cleaned and disinfected chutes and other facilities shall be provided for the exclusive unloading and loading of such cattle at Raleigh.

(*c*) Such cattle shall be hauled in clean and disinfected wagons direct from the cars in which they arrive at Raleigh to the fair grounds, and from the fair grounds direct to the cars in which they are to be reshipped.

(*d*) That portion of the fair grounds and other premises to be occupied by such cattle shall have been inaccessible to other cattle for at least six months previous to the date of the opening of the fair.

(*e*) The hay, straw, or similar material required for feed and bedding by such cattle during the time they are within the quarantined area shall be shipped in cleaned and disinfected cars from points outside of the quarantined area and so handled at Raleigh that it may not become infectious.

(*f*) Such cattle shall not be returned from Raleigh to points outside of the quarantined area except in cleaned and disinfected cars, nor unless accompanied by a certificate issued by an inspector of the Bureau of Animal Industry, showing that such cattle have had no opportunity to become infected with the cattle tick (*Margaropus annulatus*).

Done at Washington this 3d day of September, 1910.

Witness my hand and the seal of the Department of Agriculture.

[SEAL.] W. M. HAYS, *Acting Secretary of Agriculture.*

AMENDMENT 2 TO B. A. I. ORDER 168.

Amendment 2 to Rule 1, Revision 6.—To Prevent the Spread of Splenetic Fever in Cattle. Amendment Regarding the Return of Cattle of the Nonquarantined Area that are Exhibited at the Arkansas State Fair at Hot Springs, Ark., October 10 to 15, 1910.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

It is ordered that that portion of rule 1, revision 6, to prevent the spread of splenetic fever in cattle, effective on and after April 1, 1910, which relates to the quarantine in the State of Arkansas, is hereby modified to permit the interstate shipment to points outside the quarantined area as uninfected cattle, of cattle of the nonquarantined area that are exhibited at the Arkansas State Fair, to be held at Hot Springs, Ark., October 10 to 15, 1910, subject to the following restrictions:

(*a*) Such cattle shall be shipped by rail to Hot Springs and shall not be unloaded in the quarantined area elsewhere than at Hot Springs.

(*b*) Separate cleaned and disinfected chutes and other facilities shall be provided for the exclusive unloading and loading of such cattle at Hot Springs.

(*c*) Such cattle shall be hauled in clean and disinfected wagons direct from the cars in which they arrive at Hot Springs to the fair grounds, and from the fair grounds direct to the cars in which they are to be reshipped.

(*d*) That portion of the fair grounds and other premises to be occupied by such cattle shall have been inaccessible to other cattle for at least six months previous to the date of the opening of the fair.

(*e*) The hay, straw, or similar material required for feed and bedding by such cattle during the time they are within the quarantined area shall be shipped in cleaned and disinfected cars from points outside of the quarantined area and so handled at Hot Springs that it may not become infectious.

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(f) Such cattle shall not be returned from Hot Springs to points outside of the quarantined area except in cleaned and disinfected cars, nor unless accompanied by a certificate issued by an inspector of the Bureau of Animal Industry, showing that such cattle have had no opportunity to become infected with the cattle tick (*Margaropus annulatus*).

Done at Washington this 12th day of September, 1910.

Witness my hand and the seal of the Department of Agriculture.

[SEAL.] JAMES WILSON, *Secretary of Agriculture.*

B. A. I. ORDER 169.

Rule 8, Revision 2.—To Prevent the Spread of Lip-and-Leg Ulceration (Necrobacillosis) in Sheep (effective on and after August 1, 1910).

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

The fact has been determined by the Acting Secretary of Agriculture, and notice is hereby given, that a contagious, communicable disease known as lip-and-leg ulceration (*necrobacillosis*) exists among sheep in the State of Wyoming.

Now, therefore, I, WILLIS L. MOORE, ACTING SECRETARY OF AGRICULTURE, under authority conferred by section 1 of the act of Congress approved March 3, 1905 (33 Stat., 1264), do hereby quarantine the following area, to wit:

All territory in the State of Wyoming situate within the boundaries of the counties of Bighorn, Johnson, Sheridan, Weston, Crook, Converse, and Natrona; and that part of Laramie County lying north of the North Platte River.

During the existence of this quarantine the interstate transportation, movement, trailing, or driving of sheep, except as hereinafter provided, from the said area herein quarantined is hereby prohibited.

Owing to the differences in the manifestations of this disease, the classification of affected and exposed sheep will be designated as follows:

1. *Exposed sheep.*—(a) Sheep which are affected with the mild or inactive form of lip-and-leg ulceration, where only one portion of the body is involved without evidence of suppuration, shall be classed as exposed sheep after they have been hand treated under the supervision or direction of an employee of the Bureau of Animal Industry with an emollient dressing containing 5 parts of one of the permitted cresol or coal-tar sheep dips, 10 parts flowers of sulphur, and 100 parts of mutton tallow, vaseline, or lard, and may be shipped interstate when accompanied by a certificate of inspection and treatment issued by an inspector of the Bureau of Animal Industry, subject to the laws and regulations of the State or Territory to which they are destined.

(b) Sheep that are not infected with lip-and-leg ulceration but which have been exposed to sheep showing the disease in the malignant form, or to the contagion of the disease in the malignant form through infected corrals, pens, and chutes used by sheep so affected with the disease, may be shipped interstate in cars placarded as hereinafter provided to a recognized slaughtering center for immediate slaughter, without dipping, or they may be moved interstate for breeding or feeding purposes under the conditions hereinafter provided for such sheep.

(c) *Breeders.*—Sheep that are not visibly diseased with lip-and-leg ulceration but which are part of a band of diseased sheep may be moved interstate from the quarantined area or from public stock yards for breeding purposes, provided they are held seven days for a second inspection before such interstate movement, and further provided that if, upon such second inspection, disease is found, the animals apparently free shall be segregated and properly dipped before their interstate movement is permitted.

(d) *Feeders.*—Sheep that are not diseased with lip-and-leg ulceration but which are part of a band of diseased sheep, or sheep slightly diseased after the hand treatment described in paragraph (a), or sheep that have been exposed to the disease through infected corrals, pens, or chutes used by diseased sheep, may, without dipping, be moved interstate from the quarantined area or from public stock yards for feeding or grazing in fenced inclosures, provided permission shall have been obtained in advance of the movement from the proper official of the State or Territory into which the sheep are to be shipped. If the permission of such State or Territorial official is not obtained the sheep shall, before being moved interstate, be dipped as hereinafter provided for sheep exposed to disease through infected corrals, pens, or chutes.

2. *Diseased sheep.*—Sheep affected with lip-and-leg ulceration which show the disease in more than one tissue and show pus formation to a greater extent than indicated for exposed sheep shall be classed as diseased sheep, and shall under no condition be moved interstate from the quarantined area.

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3. *Healthy sheep.*—Sheep that are not affected with lip-and-leg ulceration nor exposed to sheep showing lesions of more than one tissue accompanied by pus formation may be moved interstate when accompanied by a certificate of inspection from an inspector of the Bureau of Animal Industry.

4. *Dipping.*—When it is desired to dip sheep for interstate movement as hereinbefore provided, the dipping shall be done under the supervision of an employee of the Bureau of Animal Industry and in one of the cresol or coal-tar creosote dips permitted by the Department of Agriculture in the official dipping of sheep for scabies, provided the dip is used at a strength specified for use in the dipping of sheep for scabies. The dipping fluid shall be thoroughly mixed before flowing into the vat and also before the sheep are placed therein. The dip shall be maintained at a temperature of from 85° to 95° F., and the sheep shall be retained therein about one miunte. The dipping shall be done carefully and the sheep handled as humanely as possible. The department disclaims responsibility for any loss or damage resulting from the dipping.

5. *Placarding cars.*—When, as hereinbefore provided, exposed sheep or sheep of diseased bands are shipped interstate without dipping, for immediate slaughter, the proper officers of the transportation company shall affix to both sides of each car a durable placard not less than 6½ by 10 inches in size, on which shall be printed with permanent black ink in boldface letters not less than 1½ inches in height the words "SHEEP FOR SLAUGHTER EXPOSED TO LIP-AND-LEG ULCERATION." These placards shall also show the name of the place from which the shipment was made, the date of the shipment (which must correspond with the date of the waybills and other papers), the name of the transportation company, and the name of the place of destination. Each of the waybills, conductors' manifests, memoranda, and bills of lading pertaining to such shipments by cars or boats shall have the words "EXPOSED TO LIP-AND-LEG ULCERATION" plainly written or stamped on its face.

Whenever such shipments are transferred to another transportation company or into other cars or into other boats, or are rebilled or reconsigned to a point other than the original destination, the cars into which said sheep are transferred and the new waybills, conductors' manifests, memoranda, and bills of lading covering such shipments by cars or boats shall be marked as herein specified for cars first carrying said sheep and for the billing, etc., covering the same. If for any reason the placards herein required are removed from the car or are destroyed or rendered illegible, they shall be immediately replaced by the transportation company or its agents, the intention being that legible placards shall be maintained on the cars from the time of shipment until they arrive at destination and the disposition of the cars is indicated by an inspector of the Bureau of Animal Industry.

6. *Disinfection.*—All public stock yards, feeding stations and approaches, chutes, alleys, and pens thereof which have contained diseased animals shall, before healthy or nonexposed animals for interstate transportation are placed therein, be cleaned and disinfected as hereinafter provided. Failure to clean and disinfect said places will subject them to quarantine.

Cars and other vehicles, yards, pens, sheds, chutes, alleys, etc., that have contained diseased sheep shall be cleaned and disinfected in the following manner: Remove all litter and manure from all portions of the cars, including the ledges and framework outside, and from the posts, floors, and fences of yards, pens, sheds, chutes, alleys, etc., and empty all troughs, racks, or other feeding or watering facilities; then saturate the entire interior surface of the cars, including the inner surface of the car doors, or the entire surface of the fences, posts, floors, troughs, and racks of the yards, pens, sheds, chutes, alleys, etc., with a 5 per cent solution of pure carbolic acid, or with a 3 per cent solution of liquor cresolis compositus, U. S. P.

7. All sheep originating in any State or Territory and which are unloaded at stockyards where Federal inspection is maintained will be inspected and handled in accordance with the regulations contained in this order before being permitted to move interstate.

The effect of this order is to release from quarantine that territory now designated as Park County, formerly a portion of Bighorn County; that part of Fremont County north of the Sweetwater River; that part of Albany County north of the sixth standard parallel north; and that part of Laramie County lying north of the sixth standard parallel north and south of the North Platte River. In addition it revokes B. A. I. Order 165, and generally outlines the manner in which sheep may be moved interstate from the area herein quarantined and from stockyards where Federal inspection is maintained.

This rule 8, revision 2, which for the purpose of identification is designated as B. A. I. Order 169, will become and be effective on and after August 1, 1910, and is subject to amendment or revision on statutory notice.

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Rule 8, revision 1, dated November 13, 1909, and effective on and after November 22, 1909, is hereby revoked.

Done at Washington this 22d day of July, 1910.

Witness my hand and the seal of the Department of Agriculture.

[SEAL.] WILLIS L. MOORE, *Acting Secretary of Agriculture.*

AMENDMENT 1 TO B. A. I. ORDER 169.

Amendment 1, Rule 8, Revision 2.—To Prevent the Spread of Lip-and-Leg Ulceration (Necrobacillosis) in Sheep (effective on and after October 17, 1910).

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

The fact has been determined by the Secretary of Agriculture, and notice is hereby given, that the contagious disease known as lip-and-leg ulceration (necrobacillosis) exists to a slight extent only among sheep in the counties of Bighorn and Sheridan, in the State of Wyoming, quarantined by rule 8, revision 2, dated July 22, 1910, and effective August 1, 1910.

Now, therefore, I, JAMES WILSON, SECRETARY OF AGRICULTURE, under authority of law, do hereby amend said rule 8, revision 2, to prevent the spread of lip-and-leg ulceration (necrobacillosis) in sheep, in the following particulars, to wit:

That part of said rule which specifies the quarantined portion of the State of Wyoming is amended to read as follows:

In WYOMING the counties of Johnson, Weston, Crook, Converse, and Natrona, and that part of Laramie County lying north of the North Platte River.

The effect of this order is to release from quarantine on account of lip-and-leg ulceration (necrobacillosis) in sheep the counties of Bighorn and Sheridan, in the State of Wyoming.

Done at Washington this 10th day of October, 1910.

Witness my hand and the seal of the Department of Agriculture.

[SEAL.] JAMES WILSON, *Secretary.*

AMENDMENT 2 TO B. A. I. ORDER 169.

Amendment 2, Rule 8, Revision 2.—To Prevent the Spread of Lip-and-Leg Ulceration (Necrobacillosis) in Sheep (effective on and after January 16, 1911).

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

The fact has been determined by the Secretary of Agriculture, and notice is hereby given, that the contagious disease known as lip-and-leg ulceration (necrobacillosis) exists to a slight extent only among sheep in the counties of Johnson and Laramie, in the State of Wyoming, quarantined by Rule 8, Revision 2, dated July 22, 1910, and effective August 1, 1910.

Now, therefore, I, JAMES WILSON, SECRETARY OF AGRICULTURE, under authority of law, do hereby amend said Rule 8, Revision 2, to prevent the spread of lip-and-leg ulceration (necrobacillosis) in sheep in the following particulars, to wit:

That part of said rule which specifies the quarantined portion of the State of Wyoming is amended to read as follows:

In WYOMING the counties of Weston, Crook, Converse, and Natrona.

The effect of this order is to release from quarantine on account of lip-and-leg ulceration (necrobacillosis) in sheep the county of Johnson, and that part of Laramie County lying north of the North Platte River, in the State of Wyoming.

Done at Washington this 19th day of December, 1910.

Witness my hand and the seal of the Department of Agriculture.

[SEAL.] JAMES WILSON, *Secretary.*

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B. A. I. ORDER 170.

Special Order Modifying the Tuberculin Test Requirement for Canadian Cattle Imported Temporarily for Exhibition Purposes at the Michigan State Agricultural Society Fair, to be held at Detroit, Mich.

U. S. DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 7, 1910.

Under authority conferred upon the Chief of the Bureau of Animal Industry by Regulation 38 of Bureau of Animal Industry Order 142, "Regulations for the inspection and quarantine of horses, cattle, sheep, and other ruminants, and swine imported into the United States," the requirements of regulation 37 of order 142 are hereby waived for cattle to be imported from Canada temporarily for exhibition purposes at the Michigan State Agricultural Society Fair, to be held at Detroit, Mich., from September 19 to 24, 1910.

The provisions of said regulation 38 shall be strictly applied to the cattle covered by this order. Regulation 38 reads as follows:

"REGULATION 38. The Chief of the Bureau of Animal Industry may, however, by written order, waive the foregoing tuberculin test requirement for cattle to be imported temporarily for exhibition purposes, provided such cattle are accompanied by a satisfactory certificate of tuberculin test made not more than six months previously and an affidavit by the owner or importer stating that said certificate of tuberculin test refers to the cattle in question. Any such cattle which are not sold to remain in the United States shall be returned immediately to Canada at the close of the exhibition. The department must be notified of any Canadian cattle which will remain in the United States not tested as required by regulation 37, and the tuberculin test will be applied to them by an inspector of this department before shipment to destination. All cattle, sheep, and swine intended for exhibition purposes must be shipped directly to the exhibition grounds and must not be unloaded in any public stock yards."

A. M. FARRINGTON,
Acting Chief of Bureau of Animal Industry.

B. A. I. ORDER 171.

Special Order Modifying the Tuberculin Test Requirement for Canadian Cattle Imported Temporarily for Exhibition Purposes at the Fair to be Held at Ogdensburg, N. Y.

U. S. DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 7, 1910.

Under authority conferred upon the Chief of the Bureau of Animal Industry by regulation 38 of Bureau of Animal Industry Order 142, "Regulations for the inspection and quarantine of horses, cattle, sheep, and other ruminants, and swine imported into the United States," the requirements of regulation 37 of order 142 are hereby waived for cattle to be imported from Canada temporarily for exhibition purposes at the fair to be held at Ogdensburg, N. Y., from September 19 to 23, 1910.

The provisions of said regulation 38 shall be strictly applied to the cattle covered by this order. Regulation 38 reads as follows:

"REGULATION 38. The Chief of the Bureau of Animal Industry may, however, by written order, waive the foregoing tuberculin test requirement for cattle to be imported temporarily for exhibition purposes, provided such cattle are accompanied by a satisfactory certificate of tuberculin test made not more than six months previously and an affidavit by the owner or importer stating that said certificate of tuberculin test refers to the cattle in question. Any such cattle which are not sold to remain in the United States shall be returned immediately to Canada at the close of the exhibition. The department must be notified of any Canadian cattle which will remain in the United States not tested as required by regulation 37, and the tuberculin test will be applied to them by an inspector of this department before shipment to destination. All cattle, sheep, and swine intended for exhibition purposes must be shipped directly to the exhibition ground and must not be unloaded in any public stock yards."

A. M. FARRINGTON,
Acting Chief of Bureau of Animal Industry.

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B. A. I. ORDER 172.

Special Order Modifying the Tuberculin Test Requirement for Canadian Cattle Imported Temporarily for Exhibition Purposes at the International Live Stock Exposition, Chicago, Ill.

U. S. DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., November 17, 1910.

Under authority conferred upon the Chief of the Bureau of Animal Industry by regulation 38 of Bureau of Animal Industry Order 142, "Regulations for the inspection and quarantine of horses, cattle, sheep, and other ruminants, and swine imported into the United States," the requirements of regulation 37 of order 142 are hereby waived for cattle to be imported from Canada temporarily for exhibition purposes at the International Live Stock Exposition, to be held at Chicago, Ill., from November 26 to December 3, 1910.

The provisions of said regulation 38 shall be strictly applied to the cattle covered by this order. Regulation 38 reads as follows:

"REGULATION 38. The Chief of the Bureau of Animal Industry may, however, by written order, waive the foregoing tuberculin test requirement for cattle to be imported temporarily for exhibition purposes, provided such cattle are accompanied by a satisfactory certificate of tuberculin test made not more than six months previously and an affidavit by the owner or importer stating that said certificate of tuberculin test refers to the cattle in question. Any such cattle which are not sold to remain in the United States shall be returned immediately to Canada at the close of the exhibition. The department must be notified of any Canadian cattle which will remain in the United States not tested as required by regulation 37, and the tuberculin test will be applied to them by an inspector of this department before shipment to destination. All cattle, sheep, and swine intended for exhibition purposes must be shipped directly to the exhibition grounds and must not be unloaded in any public stock yards."

A. D. MELVIN,
Chief of the Bureau of Animal Industry.

B. A. I. ORDER 173.

Special Order Providing for the Importation of Canadian Sheep for Exhibition Purposes at the International Live Stock Exposition, Chicago, Ill.

U. S. DEPARTMENT OF AGRICULTURE, OFFICE OF THE SECRETARY,
Washington, D. C., November 17, 1910.

Under the authority conferred by section 2 of the Act of Congress approved February 2, 1903 (33 Stat., 791), I, JAMES WILSON, SECRETARY OF AGRICULTURE, do hereby order that from this date to November 30, 1910, sheep may be imported into the United States from Canada for exhibition purposes at the International Live Stock Exposition, to be held at Chicago, Ill., from November 26 to December 3, 1910, inclusive, without being subject to 30 days' quarantine: *Provided,* Such sheep are shipped directly to the exposition grounds and are not unloaded en route into any public stock yards, that they pass a satisfactory inspection at the port of entry, and are accompanied by an affidavit of the owner or importer and a certificate issued by an authorized official Canadian veterinarian, as required by amendment 3 to B. A. I. Order 142, amending regulation 41 of the Regulations for the Inspection and Quarantine of Horses, Cattle, Sheep, and Other Ruminants, and Swine Imported into the United States: *And provided further,* That such sheep which are not allowed to remain in the United States, as hereinafter provided, shall be returned to Canada immediately upon the close of said exposition.

Such sheep, however, may remain in the United States for breeding purposes, provided the owner or importer thereof shall notify the Bureau of Animal Industry, through its veterinary inspector in charge at Chicago, that such sheep are intended for such purposes, when the sheep shall be placed and maintained in quarantine at the exposition grounds, under the supervision of an inspector of the Bureau of Animal Industry, for a period of 30 days, dating from their entry into the United States, and provided at the termination they are found free from any contagious, infectious, or communicable disease, in which event such inspector will issue a certificate permitting their shipment in the United States.

[SEAL.] JAMES WILSON, *Secretary of Agriculture.*

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B. A. I. ORDER 174.

Special Order Prohibiting the Landing of Horses, Asses, Mules, Sheep, Goats, and Swine from any of the Countries of Asia and Africa at any of the Ports of the United States, the Territories, or Dependencies Thereof.

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

Notice is hereby given to the owners, officers, and agents of all steamers and other vessels of all descriptions plying between the countries of Asia and Africa and any of the ports of the United States, the Territories, or dependencies thereof, and to all stockmen and other persons concerned in any manner in the traffic in animals in or with the said countries of Asia and Africa, that certain contagious, infectious, and communicable diseases dangerous to the live stock of the United States exist among the animals of the said countries of Asia and Africa, viz, surra, affecting horses, mules, and asses; foot-and-mouth disease, affecting horses, sheep, goats, and swine; rinderpest, affecting sheep, goats, and swine.

Now, therefore, under the authority conferred upon me by the act of Congress approved February 2, 1903, entitled "An act to enable the Secretary of Agriculture to more effectually suppress and prevent the spread of contagious and infectious diseases of live stock, and for other purposes," I do hereby prohibit the landing at any of the ports of the United States and Territories, or dependencies thereof, of any horses, asses, mules, sheep, goats, and swine from the said countries of Asia and Africa. This prohibition shall take effect immediately and shall continue in force until otherwise ordered.

Done at Washington this 16th day of November, 1910.

Witness my hand and the seal of the United States Department of Agriculture.

[SEAL.] W. M. HAYS, *Acting Secretary of Agriculture.*

B. A. I. ORDER 175.

Regulations Governing the Certification of Recognized Breeds and Pure-Bred Animals.

DEPARTMENT OF AGRICULTURE, OFFICE OF THE SECRETARY,
Washington, D. C., November 25, 1910.

Under authority of paragraph 492 of the act of Congress approved August 5, 1909, entitled "An act to provide revenue, equalize duties, and encourage the industries of the United States, and for other purposes" (36 Stat., 11), the following regulations are issued governing the certification of recognized breeds and purebred animals imported into the United States for breeding purposes. For purposes of identification, these regulations are designated as B. A. I. Order 175, and supersede all previous regulations on the same subject. They shall become and be effective on and after January 1, 1911. All previous certifications are hereby canceled to be effective on and after January 1, 1911.

JAMES WILSON, *Secretary.*

REGULATION 1.—CERTIFICATION OF PUREBRED ANIMALS.

SECTION 1. *Bureau of Animal Industry to issue certificates.*—The Bureau of Animal Industry of the Department of Agriculture is hereby authorized to issue certificates of pure breeding under the provisions of this order.

SECTION 2. *How to obtain certificates.*—In order to obtain such certificates of pure breeding, importers shall conform to the following procedure:

Paragraph 1. Application for certificates.—An application for certificates shall be made to the Bureau of Animal Industry on forms furnished or approved by the department, showing the number of animals to be imported, the breed and sex, the port of shipment, the port of entry into the United States, the name of vessel by which shipped, and the probable date of arrival. This application may be signed either by the owner, the importer, or the agent, stating the name and address (in the United States) of the owner of the animal or animals.

Paragraph 2. Certificates of pedigree.—Certificates of registration and pedigree for said animal or animals, issued by the custodian of one of the books of record given in regulation 2, section 4, of this order, shall be furnished to the Bureau of Animal Industry with the application.

Paragraph 3. Vendor's certificates.—A certificate from the seller or his agent shall be furnished to the Bureau of Animal Industry with the application, giving the name and registry number of each animal sold to the importer, the date of sale, the place of purchase, and the name and address (in the United States) of the purchaser. Vendor's

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certificates furnished by the custodians of foreign books of record, containing the above information, may be used; otherwise the form of vendor's certificate furnished or approved by this department must be used.

SECTION 3. Applications will be given consideration by the department in the order in which they are received. When the application and accompanying papers are satisfactory, certificates to that effect will be issued promptly and forwarded to the inspector of the Bureau of Animal Industry at the port of entry or at the station where the animals are quarantined, which officer will compare the animals imported with the data furnished in the foreign pedigree certificates, and where satisfactory, both the foreign pedigree certificates and the certificates of the Bureau of Animal Industry will be given to the owner, importer, or agent. All papers for animals which do not meet the requirements of this order will be retained or returned in the discretion of the department.

SECTION 4. *Eligibility of animals.*—Where the provisions of this order have been otherwise complied with, animals will be certified as purebred which have been fully registered in good faith in one of the books of record for one of the recognized breeds given in regulation 2, section 4, of this order, except those which have been registered on inspection.

REGULATION 2.—CERTIFICATION OF RECOGNIZED BREEDS.

SECTION 1. *Application for certification.*—Before an additional breed to those shown in section 4 of this regulation shall be added to this order, the custodian of its book of record shall submit to the department a complete set of the published volumes of such book of record to date of making application, together with all rules in force on said date affecting the registration of animals in said book of record. The department will consider the case on its merits and use such information as may be available to determine whether the breed is a recognized breed and whether the animals registered in the book of record are purebred.

SECTION 2. *Official communications.*—All official communications submitted under the provisions of this order should be addressed to the Chief of the Bureau of Animal Industry, Department of Agriculture, Washington, D. C., except as mentioned below.

SECTION 3. *Books of record required.*—Custodians of books of record for certified breeds shall forward volumes of their books of record as soon as published addressed to the Chief of the Bureau of Animal Industry, in care of the United States despatch agent, 2 Rector Street, New York, N. Y., U. S. A.

SECTION 4. *Recognized breeds.*—The following breeds of domestic animals have been certified to the Secretary of the Treasury on this date. Opposite will be found the names of the foreign books of record for these breeds, with the names and addresses of their custodians.

Paragraph 1. Recognized breeds and books of record across the seas:

HORSES.

Name of breed.	Book of record.	By whom published.
Belgian Draft	Stud book des Chevaux de Trait Belges.	Société le Cheval de Trait Belge, Chevalier G. Hynderick, secretary, Brussels, Belgium.
Clydesdale	Clydesdale Studbook	Clydesdale Horse Society of the United Kingdom of Great Britain and Ireland, Archibald MacNeilage, secretary, 93 Hope Street, Glasgow, Scotland.
French Draft	Studbook des Chevaux de Trait Français.	Société des Agriculteurs de France, Henri Johanet, secretary, 8 Rue d'Athenes, Paris, France.
Hackney	Hackney Studbook	Hackney Horse Society, Frank F. Euren, secretary, 12 Hanover Square, London, W., England.
Percheron	Studbook Percheron de France.	La Société Hippique Percheronne de France, E. Lemarie, secretary, Nogent-le-Rotrou, France.
Shetland Pony	Shetland Pony Studbook	Shetland Pony Studbook Society, R. W. Walker, secretary, 3 Golden Square, Aberdeen, Scotland.
Shire	Shire Horse Society Studbook.	Shire Horse Society, J. Sloughgrove, secretary, 12 Hanover Square, London, W., England.
Suffolk	Suffolk Studbook	Suffolk Horse Society, Fred Smith, secretary, Rendlesham, Woodbridge, Suffolk, England.
Thoroughbred	Australian Studbook	W. C. Yuille & Sons, Melbourne, Australia.
	General Studbook	Weatherby & Sons, 6 Old Burlington Street, London, W., England.
Welsh Pony and Cob	Welsh Pony and Cob Studbook.	The Welsh Pony and Cob Society, John R. Bache, secretary, Knighton, Radnorshire, Wales.

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CATTLE.

Name of breed.	Book of record.	By whom published.
Aberdeen-Angus	The Aberdeen-Angus Herd Book.	The Aberdeen-Angus Cattle Society, James R. Barclay, secretary, 9 Old Market Place, Banff, Scotland.
Alderney	Royal Alderney Agricultural Society's Herd Book.	Royal Alderney Agricultural Society, N. W. Gaudion, secretary, Lower Victoria Street, Alderney, Island of Alderney.
Ayrshire	Ayrshire Herdbook	Ayrshire Cattle Herdbook Society of Great Britain and Ireland, John Howie, secretary, 58 Alloway Street, Ayr, Scotland.
Devon	Davy's Devon Herdbook	Devon Cattle Breeders' Society, John Risdon, jr., secretary, Wiveliscombe, Somerset, England.
Galloway	Galloway Herdbook	Galloway Cattle Society, Rev. John Gillespie, secretary, Mouswald Manse, Ruthwell, R. S. O., Dumfriesshire, Scotland.
Guernsey	English Guernsey Herdbook	English Guernsey Cattle Society, Robert F. Ling, secretary, 12 Hanover Square, London, W., England.
	Guernsey Herdbook	Royal Guernsey Agricultural Society, Henry Carré, secretary, St. Peter's Port, Island of Guernsey.
Hereford	Herdbook of Hereford Cattle.	Hereford Herdbook Society, W. C. G. Britten, secretary, 20 East Street, Hereford, England.
Highland	Highland Herdbook	Highland Cattle Society of Scotland, Duncan Shaw, secretary, 15 High Street, Inverness, Scotland.
Holstein-Friesian	Friesian Herdbook (Friesch Rundvee-Stamboek).	Friesch Rundvee-Stamboek, Dr. E. van Welderen Rengers, secretary, Leeuwarden, Holland.
	Netherlands Herdbook (Nederlandsch Rundvee-Stamboek).	Vereeniging het Nederlandsche Rundvee-Stamboek, H. C. Waldeck, secretary, Loosduinen, Holland.
	North Holland Herdbook (Rundvee-Stamboek "Nord Holland").	Vereeniging het Rundvee-Stamboek "Nord Holland," D. Laan, secretary-treasurer, Schellinkhout, Holland.
Jersey	Jersey Herdbook	Royal Jersey Agricultural Society, John A. Perree, secretary, 8 Church Street, St. Helier, Island of Jersey.
	English Herdbook and Register of Jersey Cattle.	English Jersey Cattle Society, T. W. Hammond and L. J. Craufurd, secretaries, 19 Bloomsbury Square, London, W. C., England.
Kerry and Dexter	English Kerry and Dexter Herdbook.	English Kerry and Dexter Cattle Society, T. W. Hammond and L. J. Craufurd, secretaries, 19 Bloomsbury Square, London, W. C., England.
	Royal Dublin Society Kerry and Dexter Herdbook.	Royal Dublin Society, Richard J. Moss, secretary, Leinster House, Dublin, Ireland.
Red Polled	Red Polled Herdbook	Red Polled Society of Great Britain and Ireland, Herbert P. Biofield, secretary, Morley Manor, Wymondham, Norfolk, England.
Shorthorn	Coates's Herdbook	Shorthorn Society of Great Britain and Ireland, E. J. Powell, secretary, 12 Hanover Square, London, W., England.
Sussex	Sussex Herdbook	Sussex Herdbook Society, A. G. Holland, secretary, 12 Hanover Square, London, W., England.
Welsh	Welsh Black Cattle Herdbook.	Welsh Black Cattle Society, James Thomas & Son, secretaries, 9 Victoria Place, Haverfordwest, South Wales.

SHEEP.

Cheviot	Cheviot Sheep Flock Book.	Cheviot Sheep Society, John Robson, secretary, Newton, Bellingham, Northumberland, England.
Cotswold	Cotswold Flock Book	Cotswold Sheep Society, James W. Tayler, secretary, Cold Aston, Burton-on-the-Water, Gloucestershire, England.
Dorset Horn	Dorset Horn Flock Book	Dorset Horn Sheep Breeders' Association, Thomas H. Ensor, secretary, Bank Chambers, Dorchester, Dorset, England.
Hampshire Down	Hampshire Down Flock Book.	Hampshire Down Sheep Breeders' Association, James E. Rawlence, secretary, 49 The Canal, Salisbury, England.

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SHEEP—continued.

Name of breed.	Book of record.	By whom published.
Kent or Romney Marsh	Kent or Romney Marsh Flock Book.	Kent Sheep Breeders' Association, W. W. Chapman, secretary, Room 4, Mowbray House, Norfolk Street, Strand, London, W. C., England.
Leicester	Leicester Flock Book	Leicester Sheep Breeders' Association, W. A. Brown, secretary, Elms Villa, Great Driffield, East Yorkshire, England.
Leicester (Border)	The Border Leicester Flock Book.	The Society of Border Leicester Sheep Breeders, Robert Wood, secretary, Admiral Street, Carnaustie, Scotland.
Lincoln	Lincoln Longwool Sheep Breeders' Flock Book.	Lincoln Longwool Sheep Breeders' Association, William Frankish, secretary, St. Benedict's Square, Lincoln, England.
Oxford Down	Oxford Down Flock Book	Oxford Down Sheep Breeders' Association, Howard Sammons, secretary, 19 George Street, Oxford, England.
Shropshire	Shropshire Flock Book	Shropshire Sheep Breeders' Association and Flock Book Society, Alfred Mansell & Co., secretaries, College Hill, Shrewsbury, England.
Southdown	Southdown Flock Book	Southdown Sheep Society, W. J. Wickison, secretary, 12 Hanover Square, London, W., England.
Suffolk	Suffolk Flock Book	Suffolk Sheep Society, Miss E. M. Prentice, secretary, 25 Marlborough Road, Ipswich, England.
Wensleydale	Wensleydale Flock Book	Wensleydale Longwool Sheep Breeders' Association and Flock Book Society, R. B. Hodgson, secretary, Hallwith, Spennithorne, Leyburn, England.
HOGS.		
Berkshire	British Berkshire Herdbook.	British Berkshire Society, Edgar Humfrey, secretary, Shippon, Abingdon, England.
Tamworth	Herdbook of the National Pig Breeders' Association.	National Pig Breeders' Association, John Parr, secretary, Nottingham Road, Barrowash, Derby, England.
Yorkshire	do	Do.
DOGS.		
Belgian (Griffon bruxellois, Schipperke, Chien de berger belge).	Livre des Origines Saint-Hubert.	La Société Royale Saint-Hubert, V. Du Pré, secretary general, Brussels, Belgium.
Fifty-seven recognized breeds.	Kennel Club Studbook	Kennel Club, E. W. Jaquet, secretary, 7 Grafton Street, Bond Street, London, W., England.
Foxhound	Fox Hound Kennel Studbook.	Masters of Fox Hounds Association, H. E. Preston, editor, Middlethorpe Manor, York, England.
Greyhound	Greyhound Studbook	National Coursing Club, W. F. Lamonby, keeper of the Greyhound Studbook, The Place, Great Bardfield, Braintree, Essex, England.
Harrier and Beagle	Harrier and Beagle Studbook.	Association of Masters of Harriers and Beagles, Arthur L. Mercer, secretary, Rodmersham House, near Sittingbourne, Kent, England.
Swiss	Schweizerisches Hunde-Stammbuch.	Schweizerische Kynologischen Gesellschaft, W. Tschudy, secretary, Markirchstrasse, Basel, Switzerland.
CATS.		
Long-haired (Angora or Persian); short-haired (Siamese, Manx, Mexican, Abyssinian, Indian, Russian, and Japanese).	National Cat Club Studbook and Register.	National Cat Club of England, Ed. F. Cox, secretary, 65 and 66 Chancery Lane, London, W. C., England.

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Paragraph 2, Recognized breeds and books of record in Canada.—The Canadian National Records are recognized for the following breeds, subject to the same provisions prescribed for books of record across the seas:

HORSES.

Belgian Draft.
Clydesdale.
Hackney.
Shire.
Suffolk.
Welsh Pony and Cobb.

CATTLE.

Aberdeen-Angus.
Ayrshire.
French Canadian.
Galloway.
Guernsey.
Hereford.
Jersey.
Red Polled.
Shorthorn.

SHEEP.

Cheviot.
Cotswold.
Dorset Horn.
Hampshire.
Leicester.
Lincoln.
Oxford Down.
Shropshire.
Southdown.
Suffolk.

HOGS.

Berkshire.
Duroc-Jersey.
Hampshire.
Poland-China.
Tamworth.
Yorkshire.

Paragraph 492 of the act of Congress entitled "An act to provide revenue, equalize duties, and encourage the industries of the United States, and for other purposes," approved August 5, 1909 (36 Stat., 11), is as follows:

"Any animal imported by a citizen of the United States specially for breeding purposes shall be admitted free, whether intended to be so used by the importer himself or for sale for such purpose: *Provided,* That no such animal shall be admitted free unless pure bred of a recognized breed and duly registered in the book of record established for that breed: *And provided further,* That certificate of such record and of the pedigree of such animal shall be produced and submitted to the customs officer, duly authenticated by the proper custodian of such book of record, together with the affidavit of the owner, agent, or importer that such animal is the identical animal described in said certificate of record and pedigree: *And provided further,* That the Secretary of Agriculture shall determine and certify to the Secretary of the Treasury what are recognized as breeds and purebred animals under the provisions of this paragraph. The Secretary of the Treasury may prescribe such additional regulations as may be required for the strict enforcement of this provision. Cattle, horses, sheep, or other domestic animals straying across the boundary line into any foreign country, or driven across such boundary line by the owner for temporary pasturage purposes only, together with their offspring, may be brought back to the United States within six months free of duty, under regulations to be prescribed by the Secretary of the Treasury: *And provided further,* That the provisions of this act shall apply to all such animals as have been imported and are in quarantine or otherwise in the custody of customs or other officers of the United States at the date of the passage of this act."

AMENDMENT 1 TO B. A. I. ORDER 175.

Amendment 1 to B. A. I. Order 175 (Regulations of the Secretary of Agriculture Governing the Certification of Recognized Breeds and Purebred Animals)—Modifying Paragraph 2, Section 4, Regulation 2, Regarding the Recognition of Animals Registered in the Canadian National Records (effective on and after January 1, 1911).

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

Paragraph 2, section 4, regulation 2, of the regulations issued by the Secretary of Agriculture, under date of November 25, 1910, regarding the recognition of specified breeds of horses, cattle, sheep, and hogs, registered in the Canadian National Records, is hereby modified so as to provide that no animal or animals registered in the Canadian National Records shall be certified by the Secretary of Agriculture as purebred except those which trace, in all crosses, to registered animals in the country where the breed originated.

Done at Washington this 8th day of December, 1910.

Witness my hand and the seal of the Department of Agriculture.

[SEAL.] JAMES WILSON, *Secretary of Agriculture.*

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B. A. I. ORDER 176.

Order Providing for the Inspection and Quarantine of Collie, Shepherd, or Sheep Dogs Imported into the United States, or the Territories thereof, from any Country of the World except North America.

U. S. DEPARTMENT OF AGRICULTURE, BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., November 25, 1910.

The fact has been determined by the Secretary of Agriculture that collie, shepherd, or sheep dogs are subject to the infection of tapeworm (*Tænia cœnurus*), the infective element causing gid, sturdy, or staggers in sheep, through the invasion of the brain and spinal canal of these animals by the cystic form of this parasite (*Cœnurus cerebralis*):

Now, therefore, I, JAMES WILSON, under authority conferred by section 2 of the act of Congress approved February 2, 1903 (33 Stat., 791), do hereby order, and notice is hereby given to the owners, officers, and agents of all steamers and other vessels of all descriptions plying between any foreign country, except the countries of North America, and the United States or the Territories thereof, and to all stockmen and all other persons concerned in any way or manner in the importation of or traffic in collies, shepherd, or sheep dogs, that all such dogs entering the United States or the Territories thereof shall be subjected to quarantine for a period not to exceed two weeks, or until it can be determined by inspection or examination by an inspector of the Bureau of Animal Industry, as to whether such dogs are the hosts of *Tænia cœnurus*. In the event it is found by such inspection or examination that such animals are so infected, they must be medically treated under the supervision of an inspector of the Bureau of Animal Industry and held in quarantine until it can be definitely determined that they are free from such infection before being allowed to be imported into the United States or to mingle with sheep or other live stock in the United States.

The ports of entry for such dogs are limited to the ports designated in the regulations of this department for the entry of animals which are subject to both inspection and quarantine, viz: On the Atlantic seaboard, Boston, Mass., New York, N. Y., and Baltimore, Md. On the Pacific seaboard, San Francisco and San Diego, Cal., and Port Townsend, Wash.

This order will take effect immediately and will continue in force until otherwise ordered.

JAMES WILSON, *Secretary of Agriculture.*

B. A. I. ORDER 177.

Special Order Providing for the Importation of Canadian Sheep for Exhibition Purposes at the National Midwinter Sheep Show, Portland, Oreg.

U. S. DEPARTMENT OF AGRICULTURE, OFFICE OF THE SECRETARY,
Washington, D. C., December 22, 1910.

Under the authority conferred by section 2 of the act of Congress approved February 2, 1903 (33 Stat., 791), I, JAMES WILSON, SECRETARY OF AGRICULTURE, do hereby order that from December 28, 1910, to January 5, 1911, sheep may be imported into the United States from Canada for exhibition purposes at the National Midwinter Sheep Show, to be held at Portland, Oreg., from January 4 to January 7, 1911, inclusive, without being subject to 30 days' quarantine, provided such sheep are shipped directly to the exhibition grounds and are not unloaded en route into any public stockyards; that they pass a satisfactory inspection at the port of entry, and are accompanied by an affidavit of the owner or importer and a certificate issued by an authorized official Canadian veterinarian, as required by amendment 7 to B. A. I. Order 142, amending regulation 41 of the regulations for the inspection and quarantine of horses, cattle, sheep, and other ruminants, and swine imported into the United States; and provided further, that such sheep which are not allowed to remain in the United States, as hereinafter provided, shall be returned to Canada immediately upon the close of said exposition.

Such sheep, however, may remain in the United States for breeding purposes, provided the owner or importer thereof shall notify the Bureau of Animal Industry, through its veterinary inspector in charge at Portland, that such sheep are intended for such purposes, when the sheep shall be placed and maintained in quarantine at the exposition grounds, under the supervision of an inspector of the Bureau of Animal Industry, for a period of 30 days, dating from their entry into the United States, and provided at the termination they are found free from any contagious, infectious, or communicable disease, in which event such inspector will issue a certificate permitting their shipment in the United States.

JAMES WILSON, *Secretary of Agriculture.*

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Order of the Commissioners of the District of Columbia for the Suppression and Prevention of Tuberculosis in Cattle.

EXECUTIVE OFFICE, COMMISSIONERS OF THE DISTRICT OF COLUMBIA,
Washington, November 26, 1909.

Ordered: The Commissioners of the District of Columbia having learned that tuberculosis, a communicable disease, prevails among the cattle in the District of Columbia and adjacent States, do hereby, pursuant to law, authorize and direct the following measures for the prompt suppression and to prevent the spread of bovine tuberculosis within the District of Columbia and to adjoining States:

SECTION 1. It is hereby ordered that no cattle shall, in any manner, be removed from the District of Columbia except upon written permission from the Chief of the Bureau of Animal Industry or the health officer of the District of Columbia, which removal shall only be granted for cattle which have successfully passed an official tuberculin test, or are for immediate slaughter at an establishment at which United States meat inspection is maintained.

SEC. 2. Any person, firm, or corporation desiring to bring any cattle into the District of Columbia, except as provided in section 3, paragraph (*c*), shall first make application and obtain a permit from the Chief of the Bureau of Animal Industry or from the health officer of the District of Columbia. The said application shall be in writing, stating the number, sex, and the age of the cattle, whether over or under 6 months old, the exact place, date, and time at which it is desired to enter said cattle, and their destination within the District of Columbia, together with a declaration showing clearly the purpose for which the cattle are desired to be entered, whether for immediate slaughter, feeding or breeding purposes, or for milk production.

SEC. 3. (*a*) Cattle offered for entry into the District of Columbia must be accompanied by a permit, as provided in section 2, and must be identified by an official veteranarian of the Bureau of Animal Industry or of the health department of the District of Columbia, and must be appropriately tagged before entrance is permitted, except as provided in paragraph (*c*) of this section.

(*b*) Cattle over 6 months old, for purposes other than immediate slaughter, unless accompanied by a satisfactory certificate of tuberculin test by a veterinary inspector of the Bureau of Animal Industry or an official veterinarian of the health department of the District of Columbia or of the State from which brought, must be immediately taken after identification, as provided in paragraph (*a*) of this section, to a place designated by the Chief of the Bureau of Animal Industry or health officer of the District of Columbia, and there quarantined apart from all other cattle until officially tuberculin tested and disposed of in accordance with these regulations: *Provided,* That no indemnity shall be allowed for such cattle as shall be slaughtered on account of their being deemed to be tuberculous. When accompanied by certificate of tuberculin test, as herein provided, the said certificate must show the place and the date, within thirty days, of being offered for entry, of inspection and tuberculin testing, also temperature chart, description of the animal or animals, age, markings, and tag numbers, if tagged.

(*c*) Cattle for immediate slaughter may enter the District of Columbia if tagged in accordance with paragraph (*a*) and without the tuberculin test, on condition that the tag therein provided for shall remain attached to the hide until removed in the presence of an employee of the Bureau of Animal Industry or of the health department of the District of Columbia, to either of whom it shall be delivered. The owner of the animal at the time of slaughter is hereby required to notify the Chief of the Bureau of Animal Industry or the health officer of the District of Columbia, stating the place where the hides will be found. If shipped in cars and consigned direct to an establishment having United States meat inspection, cattle for immediate slaughter may enter the District of Columbia without complying with section 2 and section 3, paragraph (*a*): *Provided, however,* That the consignee shall keep a complete record of each animal received, date of receipt, its place of origin, railroads traversed, name of shipper, and butcher class to which each animal belongs, and shall report the same before the slaughter of any such animals to the Chief of the Bureau of Animal Industry through the veterinary inspector stationed at that establishment.

(*d*) Cattle under 6 months old, for purposes other than immediate slaughter, when not accompanied by certificates as indicated in paragraph (*b*), may be brought into the District of Columbia as provided in paragraph (*a*), but said cattle must be accompanied by affidavits by the breeder or feeder and by the owner or shipper; said affidavits to state that tuberculosis has not been known to exist on the premises during the six months immediately preceding the offer for entry, upon which said animals have been kept.

SEC. 4. Cattle over 6 months old already within the District of Columbia shall be inspected and tuberculin tested by a veterinary inspector of the Bureau of Animal

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Industry or of the health department of the District of Columbia. Cattle under 6 months old shall, in the same manner, be inspected, and when deemed necessary shall be tuberculin tested, said inspection and tuberculin testing to be repeated annually, or at such times as the Chief of the Bureau of Animal Industry or the health officer of the District of Columbia may direct. All such cattle shall be officially tagged "U. S. B. A. I.," with a serial number, or "U. S. B. A. I., Reacted," with a serial number.

SEC. 5. All cattle already within the District of Columbia which are deemed to be tuberculous, either as a result of physical examination or the tuberculin test, shall be slaughtered within a time and at a place designated by the Chief of the Bureau of Animal Industry or the health officer of the District of Columbia, and shall be subject to official post-mortem inspection, and the carcass of any such animal shall be disposed of according to the meat-inspection regulations of the Bureau of Animal Industry. All such cattle shall be appraised before being slaughtered, the owners to be indemnified as hereinafter provided from any available appropriation made by Congress for the Bureau of Animal Industry of the United States Department of Agriculture for carrying out the provisions of the act of May 29, 1884, except as specified in section 8 of these regulations: *Provided,* That no liability shall be incurred under these regulations by the United States Department of Agriculture in excess of the funds available from the aforesaid appropriation of Congress, and whenever the Chief of the Bureau of Animal Industry shall deem it necessary or advisable, because of the lack of funds for the aforesaid purpose, he shall notify the health officer of the District of Columbia to that effect, and thereafter no liabilities shall accrue against the United States on account of any act done or permitted under these regulations.

SEC. 6. (*a*) The health officer of the District of Columbia shall designate or request the Chief of the Bureau of Animal Industry to designate an appraiser, who shall appraise each animal within five days prior to the date of slaughter, basing the amount upon the class and market value of the animal at the time of the appraisal, whether for breeding purposes or for meat or milk production. Animals reacting to the tuberculin test but not exhibiting any physical evidence of tuberculosis shall be appraised without considering the presence of a diseased condition, but animals exhibiting any physical evidence of tuberculosis shall be appraised as diseased animals. The amount of appraisal shall not in any case exceed the sum of seventy-five dollars for a purebred and registered animal, or the sum of fifty dollars for a grade or nonregistered animal. If the amount of appraisal of any animal, as determined by the appraiser designated, is not satisfactory to the owner or owners of such animal, a written notice of such fact, setting forth the reasons for complaint, shall be forwarded upon the day of appraisal to the health officer of the District of Columbia. The amount of the appraisal shall then be determined by arbitrators, one to be appointed by the health officer of the District of Columbia or the Chief of the Bureau of Animal Industry and one by the owner or owners of the animal or animals. If the said arbitrators are not able to agree as to the amount of appraisal, a third arbitrator shall be appointed by them, whose decision shall be final. Arbitrators shall be paid at a rate of compensation not to exceed five dollars per diem and necessary expenses. Compensation for the arbitrator appointed by the owner, and the third arbitrator, if appointed, shall be paid from the fund of the United States Department of Agriculture if the decision made is against the arbitrator appointed by the health officer or the Chief of the Bureau of Animal Industry, but if the decision is in favor of such arbitrator the owner shall pay the compensation of the arbitrator appointed by him, and the third arbitrator, if appointed.

(*b*) Following the appraisal of animals, in accordance with paragraph (*a*) of this section, the amount of reimbursement shall be determined by the results of post-mortem inspection according to the following rules:

Rule 1. If any animal is found, upon post-mortem inspection, not to be affected with tuberculosis, the carcass and other edible portions shall be passed for food, and the owner shall sell the same, including all accompanying parts, for a reasonable price, which price shall be deducted from the amount of appraisal, and the balance, if any, thus remaining shall be paid from any fund available for that purpose.

Rule 2. If any animal is found, upon post-mortem inspection, to be affected with tuberculosis, and the lesions are such that the carcass and parts of the carcass are passed for food, the owner shall sell the same, including all accompanying parts, for a reasonable price, which price shall be deducted from eighty per centum of the amount of the appraisal, and the balance, if any, thus remaining shall be paid from any fund available for that purpose.

Rule 3. If any animal, upon post-mortem inspection, is condemned for offal, the owner shall sell the hide for a reasonable price, which price shall be deducted from forty per centum of the amount of the appraisal, and the balance, if any, thus remaining shall be paid from any fund available for that purpose.

SEC. 7. Any premises upon which there have been kept animals affected with tuberculosis shall be disinfected promptly after the removal of such animals, and in a manner

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satisfactory to the Chief of the Bureau of Animal Industry or the health officer of the District of Columbia, said disinfection to be at the expense of the owner or owners of the premises or of the owner of the animals.

SEC. 8. Any owner, shipper, or common carrier bringing any cattle into the District of Columbia in violation of these regulations will be liable to prosecution, and the cattle shall be immediately removed, at the owner's expense, from the District of Columbia. Such cattle, however, may remain in the District of Columbia if inspected and tuberculin tested under the following conditions: The owner or owners shall first sign an agreement providing for the inspection and tuberculin test by a veterinary inspector of the Bureau of Animal Industry or of the health department of the District of Columbia, and if any one or more of the said animals should then be deemed tuberculous, that he or they will cause such animals to be slaughtered in accordance with the specifications of section 5 of these regulations; and, further, that no claim for reimbursement for any loss which might be thus sustained will ever be made against the United States Department of Agriculture, or any other branch of the United States Government, or the District of Columbia, or any officer or department thereof.

SEC. 9. Any person violating any of these regulations, or entering cattle by fraudulent means, or using false or fraudulent tags, or interfering in any way with the work of any official, or using any false or fraudulent means to enable any cattle to pass the tuberculin test, shall be punished by a fine of not more than forty dollars nor less than five dollars.

The foregoing regulations shall go into effect upon their approval by the Secretary of Agriculture.

HENRY B. F. MACFARLAND,
HENRY L. WEST,
WILLIAM V. JUDSON,
Commissioners of the District of Columbia.

Approved, November 27, 1909.

JAMES WILSON, *Secretary of Agriculture.*

NOTE.—The States of Maryland and Virginia require tuberculin test for dairy and neat cattle entering from other States.

Amendment to Order of the Commissioners of the District of Columbia for the Suppression and Prevention of Tuberculosis in Cattle.

EXECUTIVE OFFICE,
COMMISSIONERS OF THE DISTRICT OF COLUMBIA,
Washington, March 5, 1910.

Ordered, That paragraph (*c*) of section 3 of the order of the Commissioners of the District of Columbia, of November 26, 1909, for the suppression and prevention of the spread of bovine tuberculosis within the District of Columbia and to adjoining States, is hereby amended to read as follows:

"(*c*) Cattle for immediate slaughter may enter the District of Columbia if tagged in accordance with paragraph (*a*) and without the tuberculin test, on condition that the tag therein provided for shall remain attached to the hide until removed in the presence of an employee of the Bureau of Animal Industry or of the health department of the District of Columbia, to either of whom it shall be delivered. The owner of the animal at the time of slaughter is hereby required to notify the Chief of the Bureau of Animal Industry or the health officer of the District of Columbia, stating the place where the hides will be found, *except that cattle under 6 months old, castrated cattle,* and cattle shipped in cars consigned direct to an establishment having United States meat inspection, may enter the District of Columbia for immediate slaughter without complying with section 2 and section 3, paragraph (*a*): *Provided, however,* That the consignee at any official establishment shall keep a complete record of each animal received, date of receipt, its place of origin, railroads traversed, name of shipper, and butcher class to which each animal belongs, and shall report the same before the slaughter of any such animals to the Chief of the Bureau of Animal Industry through the veterinary inspector stationed at that establishment."

The foregoing amendment shall go into effect upon its approval by the Secretary of Agriculture.

CUNO H. RUDOLPH,
JOHN A. JOHNSTON,
W. V. JUDSON,
Commissioners of the District of Columbia.

Approved March 8, 1910.

JAMES WILSON,
Secretary of Agriculture.

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